TEST
INSTRUMENT
ISSUE

HUGO GERNSBACK, Editor-in-chief · NOV. 50¢

Radio-Electronics

TELEVISION · SERVICING · HIGH FIDELITY

A GERNSBACK PUBLICATION

Ways to Get More
from Your VTVM & VOM

How to Calibrate
Your Instruments

Test Equipment
Save Your Time!

Meters for Beginners
How Do They Work?

Radio-Electronics

NOVEMBER 1964 VOL. XXXV No. 11

Over 55 Years of Electronic Publishing

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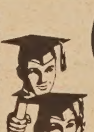

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NEWS BRIEFS

G.E. research scientist, Dr. John H. Lupinski, holds a lamp lighted by current flowing through the thin black strips of special plastic material painted on an ordinary white plastic insulator.

NEW PLASTICS ARE CONDUCTORS

A new family of conductive plastics has been announced by scientists of the General Electric Research Laboratory, Schenectady, N.Y. While these conductive plastics are far below metals in their ability to conduct, they have many characteristics which will make them useful in a large variety of new applications.

The degree of conductivity can be controlled, an additional advantage. Dr. Guy Suits, G-E vice president and director of research, however, warns that the plastics will require additional development before they can be placed on the market.

FCC POSTPONES DATE FOR NEW CB RULES

The Federal Communications Commission postponed the effective date of its clarifications of the Citizens Band regulation from November 1 to an indefinite date. It was stated that several petitions for reconsideration of the rules are outstanding, and that these petitions might not be disposed of until the middle of November. There was a feeling that the FCC might modify its proposed new rules as a result of the representations. The proposed rules, which would have considerably restricted hobby uses of the Citizens Band in favor of straight communications use, had aroused considerable controversy. Some manufacturers, notably Robert Halligan, president of Hallicrafters, thought that the new rules would increase the use of CB radio sharply, stating "The change will drastically increase the usefulness of the bands for those who really need two-way radio." On the other hand, a number of concerns, including Lafayette Radio, one of the country's largest distributors and manufacturers of CB equipment believed that the Commission's order would "adversely affect that portion of the general public which uses the Citizens Radio Service to satisfy important needs recognized to exist by the Commission."

RCA DELIVERS 25-INCH COLOR SETS

According to an estimate made at press time, new 25-inch RCA color-TV sets should now be in dealers' hands.

The announcement, largely unexexpected by trade and press alike, was made on Sept. 17 by RCA Group Executive Vice President W. Walter Watts at the opening of a new $8-million color-picture-tube plant in Lancaster, Pa.

The first 25-inch sets will range in price from about $800 to about $1,300. Lower-price models are expected after the first of the year.

RAZOR BLADES RECORD LIGHTNING

The used razor blade is well known as an electronic instrument, and was used as a detector in many a crude razor-blade radio by soldiers overseas in the last war. However, Russian scientists are beginning to use the blades for high-voltage measurements, according to a recent issue of the Russian *Electric Stations.*

According to the magazine, a wooden holder for two razor blades is mounted on a 220-kv transmission-line tower. One blade is placed 30 millimeters from one of the tower uprights, and the other about 200 millimeters from it. A framework carrying a single turn of high resistance wire is mounted on the upright and a third blade placed in it.

The blades, magnetized by the lighting stroke, are "read" by passing them rapidly through a coil of wire under carefully predetermined conditions, and measuring the resultant current. From that information, engineers can find, from the most distant razor blade, the largest current passing through the tower. From the one near the upright, they know how many times lightning struck, and from the one inside the coil, they know the maximum rate of change of the current passing through the tower. Currents up to 75,000 amperes were recorded in the razor-blade "memories", according to the Russian engineer.

NEW 3-YEAR INSTITUTE FOR ELECTRONIC TECHNOLOGISTS

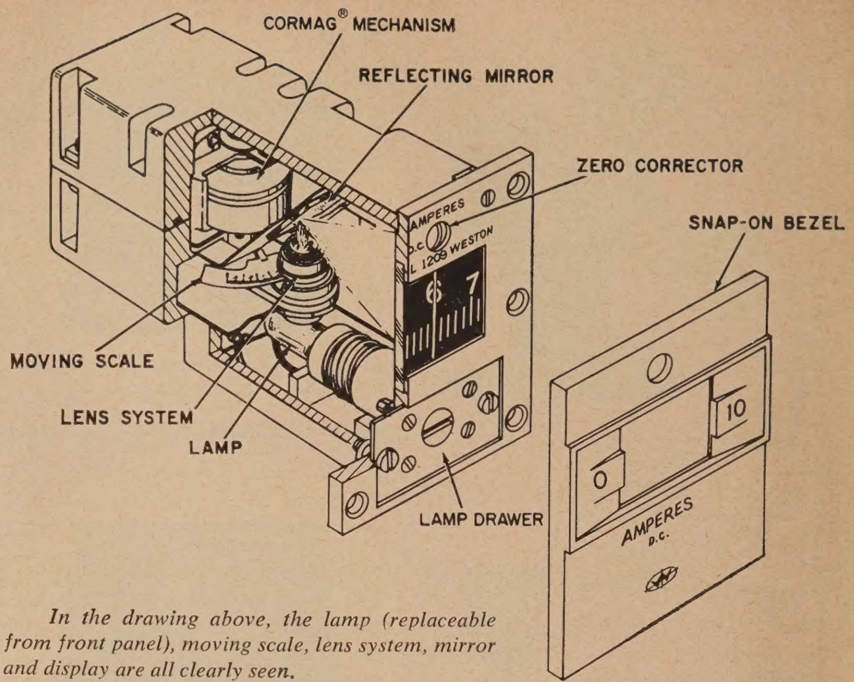
A new nonprofit 3-year school, the Capitol Institute of Technology, has been opened in Washington. Founded by the Capitol Radio Engineering Institute, it has its own officers and board of directors, separate from CREI. The new institute will take over all resident student work, leaving correspondence and international school divisions to CREI. Students who graduate from CIT will receive the degree of Associate in Applied Science.

RANGEFINDERS NOW USE LASERS

One of the new range finders, as it appeared during the testing period.

Eight laser rangefinders have been delivered to the Army by the Radio Corporation of America. Four of the devices, known as "Laser Distance Measuring Equipments," have been undergoing tests since March.

The laser is a ruby-rod type, and is pulsed. The time the light pulse requires to travel to the target and back is measured to find the range of the target. It can thus determine range accurately and rapidly from a single location without giving warning to the enemy, as a radar device would.



In the drawing above, the lamp (replaceable from front panel), moving scale, lens system, mirror and display are all clearly seen.

COMPACT PRECISION METERS USE PROJECTION OPTICS

A new meter design, which will permit a previously unheard-of combination of accuracy and compactness, has been announced by Weston Instruments. The new *Projected Moving Scale Meter* compresses into a 2-inch width a presentation which would previously have required a 9-inch-wide meter.

In a conventional meter, a moving pointer travels over a fixed scale. In the new Weston meter, a small moving scale actuated by the meter travels in front of a lens system. Light passing through the scale and the lens is reflected from a small mirror, and projected in magnified form to the meter face. Only that portion of the scale needed to read the measured value is projected, making it possible to have a relatively small face.

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INTERFERENCE FROM FM?

The large number of new FM stations is reflected in an increasing number of complaints of interference in the upper vhf television band—in almost exact second-harmonic relationship to the FM band.

A serious but sometimes unexpected trouble is caused when the FM signal overloads the input stage of the TV receiver, generating additional harmonics. In one city, such severe interference was created that an FM station had to shut down after running only one day. It was later given a different channel.

The problem is said to be especially severe in fringe areas where boosters are used to push up weak TV signals.

INTENSE RADIATION BELT MAY SURROUND MARS

Reports to the International Astronomical Union indicate that Mars may have an extremely intense belt of radiation. This would show that Mars has a magnetic field, like that of the earth. The observations resulting in these conclusions were made by the 250-foot Jodrell Bank (England) radiotelescope on a 21-cm wavelength.

NTSC AND PAL TV SYSTEMS ARE MADE COMPATIBLE

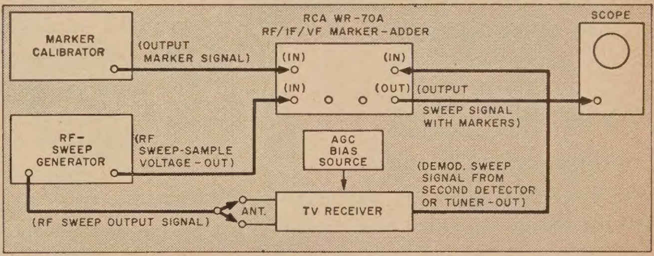
A switchable NTSC–PAL TV set was demonstrated at the Milan Color

continued on page 12

RCA Test Instruments...

EVERYTHING YOU NEED FOR ACCURATE TV ALIGNMENT

Checking overall frequency response (RF and IF) in a portable B&W TV receiver using the test instruments indicated in the block diagram below. Pattern on oscilloscope screen is an overall response curve with dual markers: one at picture-carrier frequency and one at sound-carrier frequency.



(A) RCA WR-99A CRYSTAL-CALIBRATED MARKER GENERATOR

Supplies a fundamental frequency RF carrier of crystal accuracy for aligning and trouble-shooting color and B&W TV receivers.

- Most-used IF and RF frequencies indicated on the dial scale
- Sound and picture carrier markers available simultaneously

$242.50* complete with output cable.

(B) RCA WR-70A RF/VF/IF MARKER ADDER

For use with a marker generator and a sweep generator. Used for RF, IF, and VF sweep alignment color and B&W TV receivers. In visual alignment techniques, it eliminates distortion of sweep response pattern.

$74.50* complete with four co-axial cables

(C) RCA WR-69A TELEVISION FM SWEEP GENERATOR

For visual alignment and trouble-shooting of color and B&W TV receivers, and FM receivers.

- IF/Video output frequency continuously tunable from 50 Kc to 50 Mc
- Sweep-frequency bandwidth continuously adjustable from 50 Kc to 20 Mc on IF/Video and FM; 12 Mc on TV channels

$295.00* Complete with RF output cable and IF/Video output cable.

(D) RCA WO-91A 5-INCH OSCILLOSCOPE FOR COLOR-TV

A heavy-duty, wideband precision scope, essential for TV alignment and troubleshooting.

- New 2-stage sync separator assures stable horizontal sweep lock-in on composite TV signals
- Dual bandwidth: 4.5 Mc at 0.053 volt rms/in. sensitivity. 1.5 Mc at 0.018 volt rms/in. sensitivity

$249.50* including direct/low capacitance probe and cable, ground cable, and insulated clip.

(E) RCA WG-307B TV BIAS SUPPLY

Three separate dc output voltages each adjustable from 0 to −15 volts provide bias voltages for aligning RF, IF and other circuits of COLOR and black and white TV receivers. **$11.95***

See them all at your Authorized RCA Test Equipment Distributor.

**Optional Distributor Resale Price. All prices are subject to change without notice. Prices may be higher in Alaska, Hawaii and the West.*

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

The Most Trusted Name in Electronics

NEWS BRIEFS

continued from page 8

TV convention, by Walter Bruch, manager of Telefunken Colour TV Labs. The set was a standard NTSC receiver made switchable by inserting adapters. Bruch presented the demonstration to show the close technical relationship between the American and German systems. He stressed that any ideal features of the NTSC system used in the United States and Japan should be retained, but that by adding the features of PAL, the weaknesses in hue representation can be avoided.

(PAL, SECAM, NTSC and, more recently, ART, are all systems of color television proposed for European adoption. The main objection to NTSC is that under certain transmission conditions, the reproduced colors may vary from the correct ones. PAL proposes to correct this by reversing the color distortion in each line transmitted, so that when all the lines are combined, the color distortion will be balanced out.)

CALENDAR OF EVENTS

17th Annual Conference on Engineering in Medicine & Biology, Nov. 16–18; Cleveland-Sheraton Hotel, Cleveland, Ohio

10th Conference on Magnetism & Magnetic Materials, Nov. 16–19; Raddison Hotel, Minneapolis, Minn.

15th Annual Vehicular Communications Symposium, Dec. 3–4; Cleveland-Sheraton Hotel, Cleveland, Ohio

NEW EDUCATIONAL TOY IN SPIRIT OF TV

The GE Show 'n Tell *Phono Viewer.*

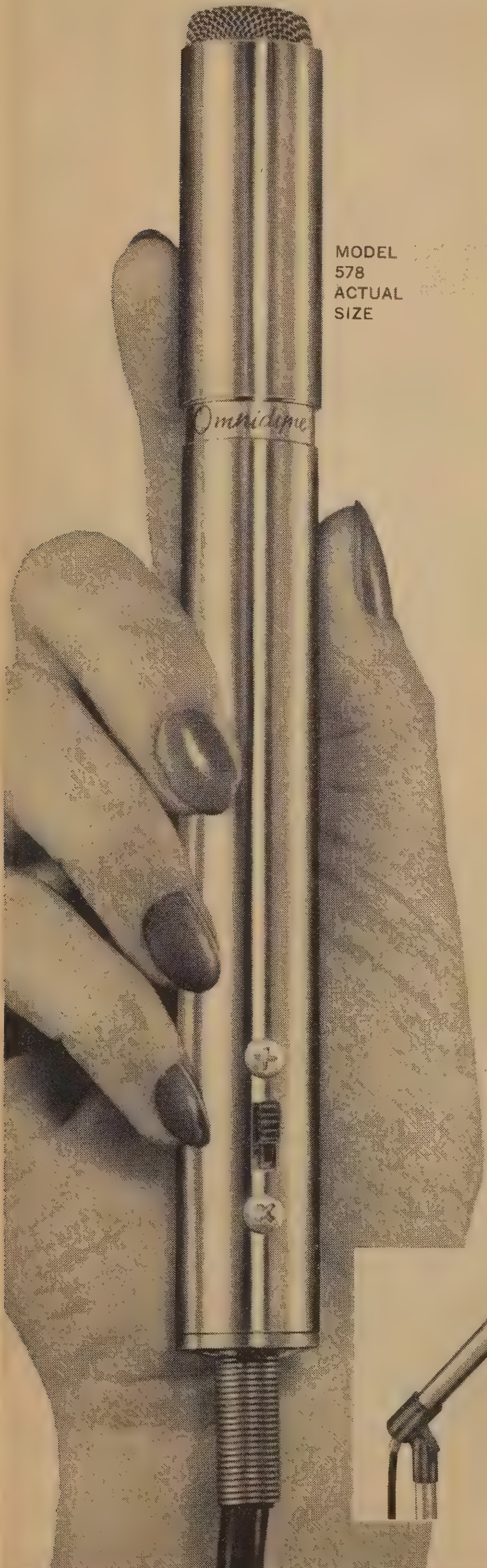
A unique children's educational toy, *Show 'n Tell Phono Viewer,* developed by General Electric, looks like an 11-inch television set. The screen is actually a slide-film viewer, and it is combined with a four-speed phonograph and transistor amplifier.

A 3-year-old child is supposed to be able to load both film and record and turn the set on. The Show 'n Tell Phono Viewer then offers a number of programs, including fairy tales and car-

the revolutionary **SHURE** 3/4" DIAMETER

OMNIDYNE* PROBE MODEL 578

*T.M.



MODEL 578 ACTUAL SIZE

GIVES you more features you want from an omnidirectional hand-held microphone

• **HANDABILITY**—Smallest, sleekest, most compact quality omnidirectional dynamic probe! 40% smaller diameter, 60% smaller area. Lockable on-off switch right on the microphone case! Balanced "heft"—feels great in the hand. Easily removed and returned to stand. Swivel adapter included.

• **UNIFORM COVERAGE**—Virtually no change in pick-up pattern or sensitivity from 50 to 17,000 cps. Easiest microphone to use because there are no "critical" areas in the pick-up pattern . . . no "hot" spots, no areas of reduced sensitivity.

• **SIMPLICITY**—Rugged, all-steel case resists abuse. No separate microphone connectors to hook-up (or accidentally fall off).

SOLVES the most common problems of other omnidirectional microphones

• **FEEDBACK**—Proved much less susceptible to feedback because its unique ultra-flat response has no undesirable peaks at any specific frequencies (a major cause of omnidirectional feedback).

• **DISTORTED SOUND**—The most natural sounding omnidirectional microphone ever developed. No "off-axis" sound coloration. Smaller diameter means there's far less of a "blind spot" in the pick-up pattern. No troublesome "boominess", no fall-off at the high end.

• **EQUALIZATION**—By far the easiest omnidirectional to equalize to the characteristics of the speaker's voice and the room acoustics . . . because it's ultra-flat . . . adds no false peaks or roll-offs of its own.

• **HUM PICK-UP**—Steel case reduces hum of the 578 to half that of any of the leading competitive units.

PERFORMS PERFECTLY in scores of diverse applications

• **VERSATILE**—In just one year, the Shure 3/4" Omnidyne probes have proved their superiority in an impressive array of applications ranging from stage and night club performances, to seminars, "pass-around" microphones in audiences, interview situations . . . anywhere and everywhere an omnidirectional is called for.

SPECIFICATIONS—Dynamic omnidirectional with ultra-flat frequency response and perfectly symmetrical pick-up pattern. 50 to 17,000 cps. Dual impedance: High impedance has –59 db output (0 db = 1 volt per microbar), 200 ohm (low) impedance has –60 db output (0 db = 1 milliwatt per 10 microbars). Trouble-free Duracoustic diaphragm. Steel, satin-chrome case. Built-in on-off switch with locking provisions. Supplied with swivel stand adaptor and 18 ft. 3-cond. shielded cable. Only 7 oz. (less cable), 3/4 in. diam., 7 3/8 in. overall length.

*Patents Pending

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222 Hartrey Ave. • Evanston, Illinois

WORLD STANDARD WHEREVER SOUND QUALITY IS PARAMOUNT

toons, children's favorite classics, history, science and space, the world we live in and steps to knowledge.

LOW-COST ELECTRONIC RANGES?

With the development of a low-cost magnetron tube, the possibility of mass production of microwave ranges for $400 to $500 retail, about half the cost of current home units, were predicted by Amperex Electronic Corp. Henry M. Steenbeke, product manager of Amperex special-purpose tubes, noted that range and vending-machine manufacturers have shown considerable interest in the development of the tube.

ELECTRONICS COURSE ON TV

A course in basic electronics, "Electronics at Work," is now being telecast in Boston, New York, Philadelphia and Altoona, Pa. It consists of ninety 30-minute sessions beginning with electrostatics and dc and progressing through TV communication systems. Study guides, including lecture material and illustrations, are available through stations carrying the program or from Electronics at Work, Box 66, West Columbia, S.C.

The course is offered by WQED—Pittsburgh, WHYY—Philadelphia, WFBG-TV—Altoona, WGBH—Boston and WNDT—New York. Broadcast times can be obtained from the stations.

ATOM VIBRATIONS NEW BASIS OF TIME

The Twelfth International Conference of Weights and Measures this year will move toward a more precise standard of measurement of time, the vibrations of the cesium atom. (The present standard is based on the length of the year 1900.) The length of the second will remain unchanged, but the greater precision will be important to scientists, because time, measured in millionths or billionths of a second, is one of the key dimensions in physics.

BRIEF BRIEFS

The Paris International Exhibition of Electronic Components will take place April 8 to 13, 1965, at the Parc des Expositions (Fairgrounds), Porte de Versailles, Paris. With it, there will be a series of International Talks on Memory Techniques, to be held at Unesco House.

The exhibition, first set up in 1934 and made international in scope in 1958, is the oldest and, to many, the most important event of its kind.

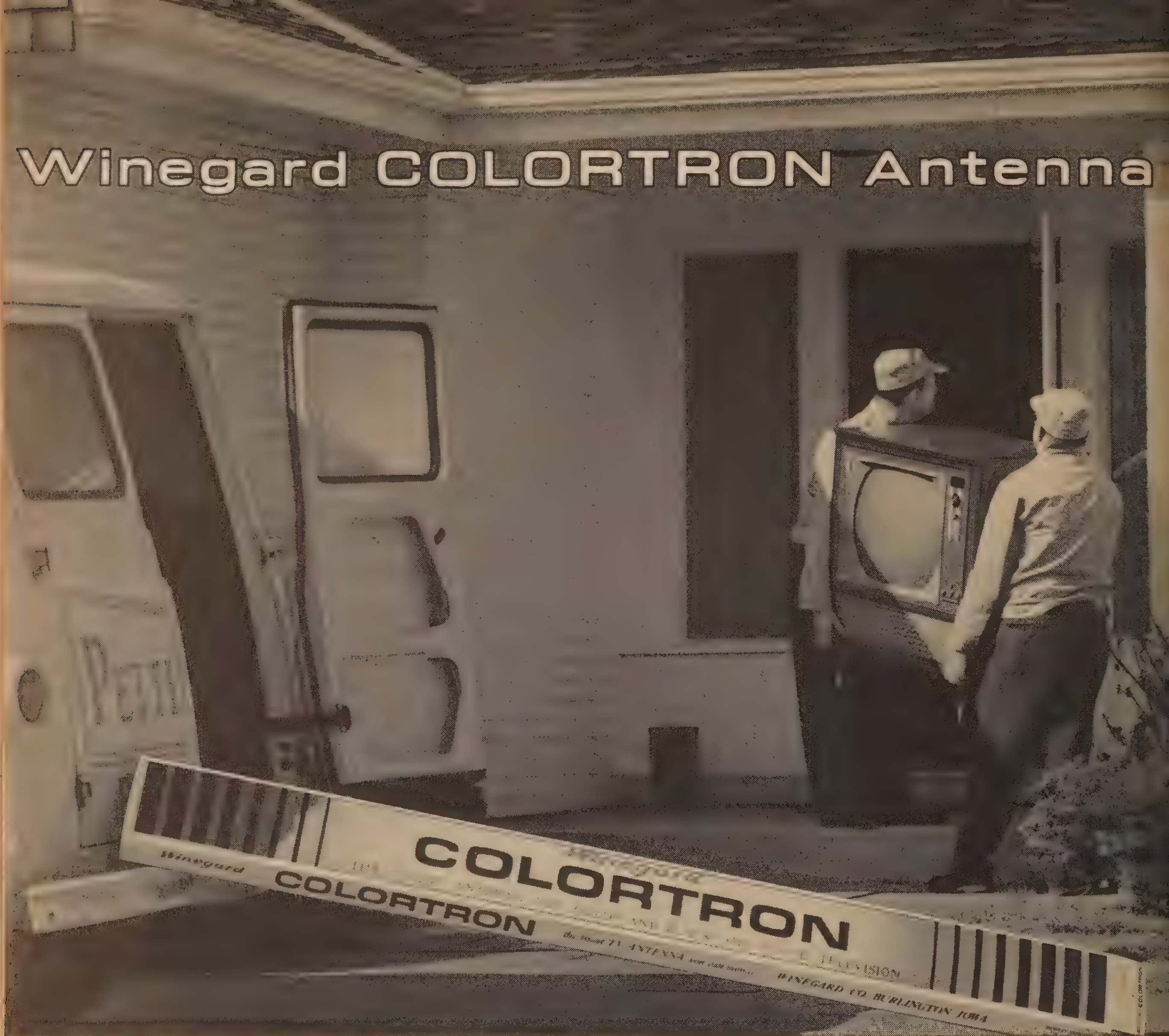
A continuous-wave output power of more than 1 watt is claimed for a new gas-discharge laser, developed by Raytheon Co., research division. The output is in the visible spectrum, with principal wavelengths at 4,880 and 5,145 Angstroms. Input, according to a Raytheon spokesman, is over 5 kilowatts.

A proposed cable distribution system of pay-TV in the Raleigh-Durham, N.C., area is being opposed by the Raleigh Committee for Free TV, in a petition signed by more than 4,500 residents of the area. Four separate cable promoters got preliminary approval in July from the Raleigh City Council to offer pay-TV service, but the citizens don't seem to want it.

Sperry Gyroscope has a pocket-sized machine for joining microcircuits into electronic products. The process is an automated soldering technique that uses jets of hot hydrogen gas to bond the tiny microcircuits onto cards that form the guts of a complex "black box".

Scientists at Bell Labs have a continuously operating gas laser that emits radiation at wavelengths as long as 133 microns. The longest wavelength previously reported was 85.147 microns.

Robert C. Sprague, chairman and treasurer of Sprague Electric Co. of North Adams, Mass., predicts that total sales of the electronics industry in the US will grow from a current volume of $15 billion to nearly $25 billion in 1973. END



The Colortron Antenna's "BALANCED DESIGN" is the Winegard secret of superior color reception!

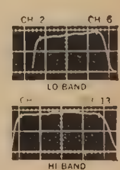
It takes a combination of high gain, accurate impedance match, complete band width and pinpoint directivity to make the perfect color antenna. Only the Winegard Colortron gives you all 4 with BALANCED DESIGN.

What is Balanced Design? It's not enough to design an antenna for high gain alone and expect good color reception. A high gain antenna without *accurate impedance match* is ineffective. Or an antenna with *good band width* but *poor directivity characteristics* is unsuitable for color. The Winegard Colortron is the one antenna with *balanced design*, excellence in *all* the important characteristics that a good color antenna requires.

For example:

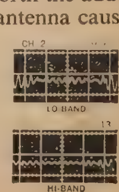
Gain and Bandwidth—A superior color antenna must have high gain and complete bandwidth as well. But the response must be *flat* if it is to be effective. Peaks and valleys in the curve of a high gain antenna can result in acceptable color on one channel and poor color on another.

No all-channel VHF-TV antenna has more gain with complete bandwidth across each and every channel than the Colortron. Look at the Colortron frequency response in this oscilloscope photo.



Note the consistent high gain in *all* channels. Note the absence of suck-outs and roll-off on end channels. The flat portion of the curve extends on the low band from the channel 2 picture carrier past the channel 6 sound carrier. On the high band, it is flat from the channel 7 picture carrier to the channel 13 sound carrier. There is less than ½ DB variance over any channel.

Impedance Match—the two 300 ohm "T" matched Colortron driven elements have far better impedance match than *any* antenna using multiple 75 ohm driven elements. The Colortron transfers *maximum* signal to the line without loss or phase distortion through mismatch. Winegard's "T" matched driven elements cost more to make, but we know the precision results are well worth the added manufacturing expense . . . because a mismatched antenna causes loss of picture quality which *might* get by in black & white, but becomes highly disturbing in color.



The oscilloscope photo here shows the Colortron VSWR curve (impedance match). No current VHF-TV antenna compares with it across all 12 channels.

Will the Space Age eliminate your job in

MANY HOURS OF ROUTINE WORK required to put together conventional circuitry are eliminated by the molecular circuitry used in this tiny video amplifier.

(Photo courtesy of Westinghouse)

Correspondence

WE MISSED THE "MISTOR"

Dear Editor:

Although your article "Watch Those Shifty Resistors" (August, page 33) covers the majority of remotely adjustable resistors, author Carl Henry has overlooked an important development, the magnetoresistor. One version of this flux-controlled resistor is manufactured under the trade name MistoR by American Aerospace Controls, Farmingdale, N.Y.

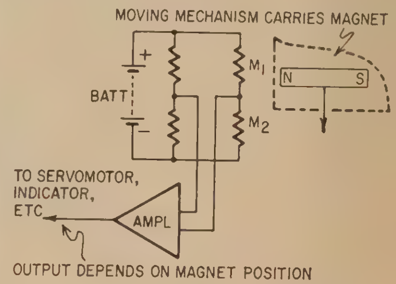


Fig.1

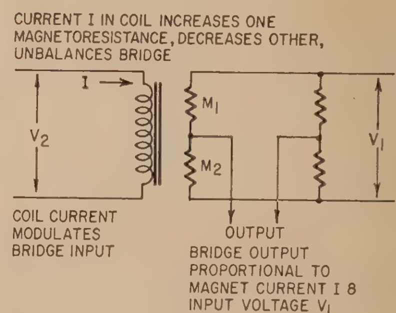


Fig.2

Like some of the other controllable resistors cited in the article, magnetoresistors are used in Wheatstone-bridge circuits for maximum output.

There are two basic applications: electromechanical controls, using a permanent magnet as the source of controlling field, and electronic controls, using a wound magnetic core to control bridge unbalance.

Figs. 1 and 2 typify these two basic arrangements. The electromechanical version, Fig. 1, is balanced when both magnetoresistors M_1 and M_2 are influenced equally by the permanent magnet. Bridge output is then zero, or "null". At other positions of the

TRAVEL FAST!

RALPH LEENDERS, LEENDERS' TV, EVERSON, WASHINGTON

"We use Paralog Antennas because of their outstanding performance and their rugged construction."

RALPH CLARK, VALAS TV CORP., DENVER, COLORADO

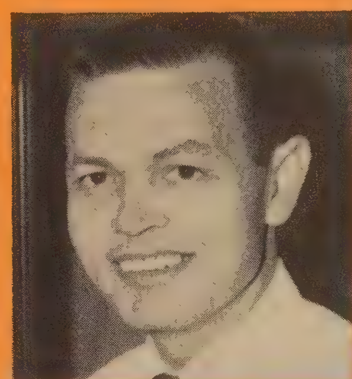
"As the largest TV sales and service company in Colorado, we can't afford to use anything but the best. After extensive comparisons and field testing, we found the Paralog to be exactly the antenna we had been looking for."

W. B. WEIDNER, ED MARLING STORES, INC., TOPEKA, KANSAS

"I've found that it pays to sell up to a Paralog. Profits are much better than on the economy antennas, and I wind up with a more satisfied customer every time."

EUGENE DOLL, DOLL'S TV, PERHAM, MINNESOTA

"Business has been terrific on Paralogs in our territory. And no wonder. Everybody who buys a Paralog is happy with the reception. We've gone to Paralog 100%."



TED WAINSCOTT, T & H SERVICE & SALES, INC. ANDERSON, INDIANA

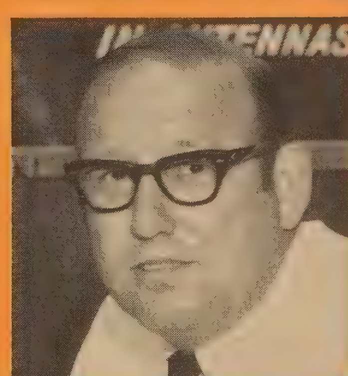
"The Paralog has proven to be far superior to any other antenna in this area. You can't beat the performance, especially on the hard-to-get channels."

RAY MAGER, MONTGOMERY WARD, LIMA, OHIO

"Paralog works better than any other VHF antenna ever made. We had 200 calls within two weeks. Some of our customers pull in Cleveland, over 160 miles away, consistently."

RUSS HELVESTON, MAKEFIELD TV, MORRISVILLE, PENNSYLVANIA

"It's very tough to get New York channels in this area, but since I've been using Paralog antennas, I can offer *guaranteed reception* to my customers. My antenna business is growing faster than ever now."



W. RAYMOND JONES, JONES TV & RADIO SERVICE, WINSTON-SALEM, N. CAROLINA

"We've been using TACO antennas for 15 years. In fact, we've installed several thousand. The new Paralogs are the most powerful and rugged antennas we've ever used."

permanent magnet, the bridge is unbalanced since the magnet influences one magnetoresistance more than the other.

This circuit is sensitive to position and direction of magnet movement. In some applications it is equivalent to a linear differential transformer; in others it provides a no-contact trigger for tachometers, stroboscopes, etc., driven from a rotating shaft.

An advantage of the magnetoresistance transducer (as a trigger for electronic ignition systems, say) is that the output voltage is independent of shaft speed (induction principle is not involved).

Electronic use of the magnetoresistance bridge is widespread, since coil current provides an isolated control of bridge output. The device can be used as a current-controlled attenuator (for agc systems, for example), as a remotely controlled fader in audio systems, and in many other control applications.

Besides use of the magnetoresistance bridge with coil control for circuit adjustment, other applications for the same package include analog multipliers, modulators, mixers, detectors, phase discriminators and power-measuring transducers.

STANLEY FROUD
New York, N.Y.

OLD "RADIO-CRAFTS" AVAILABLE

Dear Editor:

I have the following issues of *Radio-Craft* magazine (RADIO-ELECTRONICS after October 1948) available for sale. Anyone want them?

1939—October, November
1940—February, July, September
1943—November, December
1944—complete year
1945—May missing
1946-1957—complete
1958—January through May

RAYMOND M. GIERKE
3317 41st Ave. So.
Minneapolis, Minn. 55406

THE "THIRD-HAND" THEME

Dear Editor:

My compliments to RADIO-ELECTRONICS! You've scooped the electronic magazine field again by being the first to come out with news of the accessory every experimenter and technician has been awaiting.

I refer, of course, to the third hand on the technician featured on your August cover. I have been in the same predicament many times: one hand working on the underside of a chassis, one hand on the top, and in desperate need of a third to secure some loose component.

Unfortunately, you omitted some important information. I assume that the accessory hand is a bio-electronic revolution which can be attached to the elbow—but is it available in left only? As I am right-handed, I would much rather have an added right hand.

Please publish the name of the manufacturer, his address and the price of this much-needed item in your next issue. I would have written directly to the manufacturer, but I couldn't find his name anywhere in the magazine. Too bad. He could clean up.

HOWARD RUSSELL, JR.
Akron, Ohio

[You've heard of the technician with two left hands, I'm sure. RADIO-ELECTRONICS went out and found him! (Seriously, it was all done with mirrors.) —*Editor*]

RESISTORS SPLIT, BUT NOT TOO WELL

Dear Editor:

The resistor splitting circuit, published in the August issue on page 86 ("Resistors 'Split' Transformer Winding"), results in unbalanced audio drive to the push-pull tubes. At 3 kc the drive to grid 1 will be some 6 db below the drive to grid 2. This is due to the capacitance to core at the starting end of the secondary being considerably greater than the capacitance at the outer end.

As shown in Fig. 1 here, a capaci-

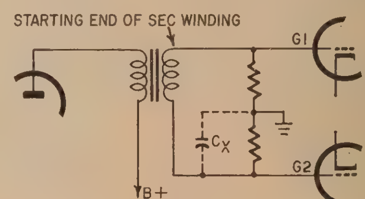


Fig.1

tor C_x added across the resistor on the "undropped" side will help compensate. Exact value must be found by experiment; it will usually lie between .001 and .005 μf.

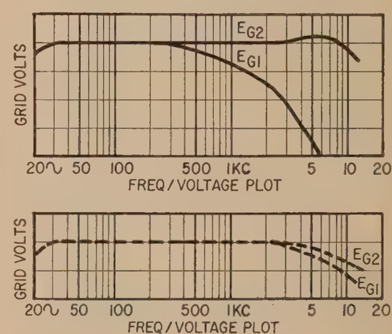


Fig.2

C_x resonates with the secondary to raise the voltage at grid 1 and lower it at grid 2 above about 2 kc. This is suitable only for "voice-quality" equip-

ment. "Before" (top) and "after" curves are shown in Fig. 2.

W. LEEMON, W8TLW/A8TLW
Fairview Park, Ohio

INTERESTED IN MEDICAL ELECTRONICS

Dear Editors:

I would like to get in touch with people interested in medical electronics (not too advanced). Specifically, I am looking for circuit diagrams. (with data if possible) of a portable transistorized heart pacemaker, a good stethoscope amplifier and an instant body-temperature reading device. Perhaps one of your readers could send me some diagrams. I will repay him for his trouble and for the postage.

I find your do-it-yourself articles especially helpful. But we often have to make our own or find substitutes here, so if you published values of transformers and coils, as well as the name of the manufacturer, it would save us some calculations.

I would like to see more articles about medical electronics. It would speed diagnosis, and often help to cure a patient.

DR. CARLOS PERES DA COSTA
Largo da Camara
Mapusa, Bardez, Goa
India

TRANSLATION, DUPLICATION, EXASPERATION

Dear Editor:

The letter from Stu Kellogg in your September issue ("Reds Should Be Read") points out that a recent RADIO-ELECTRONICS article describes a circuit very similar to one that appeared in a Russian book published last year. Mr. Kellogg suggests that American scientists and technicians miss a lot because of the language barrier. Your May editorial puts the case more strongly: "The amount of effort and money that goes into these foolish duplications is not only wasted but a constant source of embarrassment."

Spectrum Translation & Research, Inc., translates scientific and technical material into English. Most of our work is Russian into English, but we also handle other European and Asian languages.

We want to establish a translation program to meet the specific needs and interests of American scientists and technicians. What sort of material would they like translated?

W. BAKALINSKI
Vice President
Spectrum Translation & Research, Inc.
New York, N. Y.

[Readers who have ideas for Mr. Bakalinski might write to him at 207 E. 37 St., New York 16, N.Y.—*Editor*]

BUILT METAL LOCATOR

Dear Editor:

Congratulations on the quality of your articles. Information I got from your magazine helped me develop a small magnetic device which will react to a positive or negative magnetic field in an ore sample. I've recovered several gold nuggets from nearby creeks with it.

GENE YAWN
Nelson, Ga.

BETTER, LONGER TAPES FROM MIDGET RECORDERS

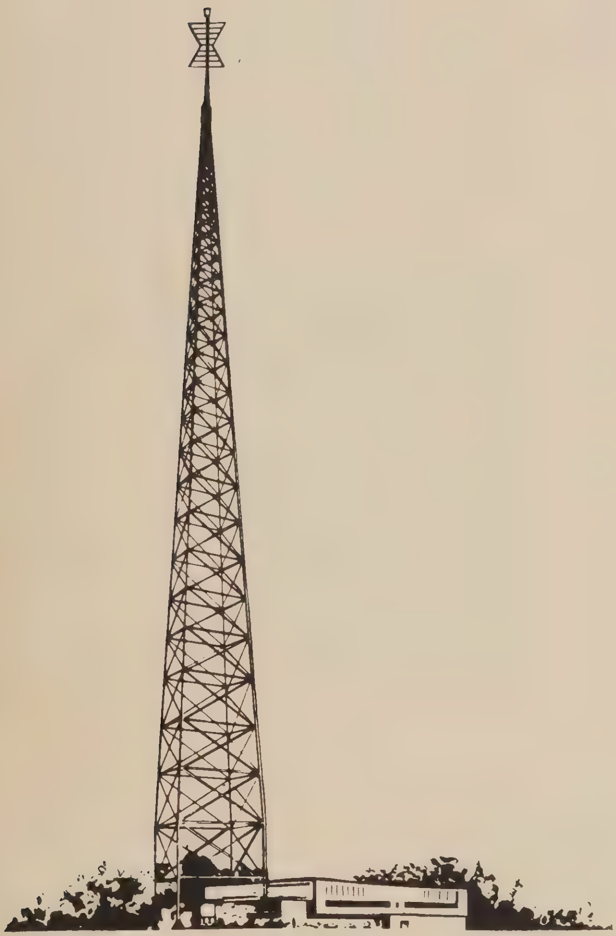
Dear Editor:

I have some suggestions for increasing tape playing time and improving the quality of recording with small rim-driven imported tape recorders. Using ½-mil tape and replacing the 3-inch reels with 3¼-inch reels increases usable playing time quite a bit. I also drilled a hole in the tape-head protective cover and inserted a pin to prevent the erase magnet from rubbing on the tape. Using bulk-erased tape and disabling the erase magnet helps reduce background noise.

I have subscribed to the Gernsback publications for 30 years, and find my back issues the finest source of reference material available.

MELVIN PLOENNIES
Marquette, Mich. END

How to deliver the best signal...



from here...

to here

BLONDER-TONGUE leader in UHF and VHF product design dedicates Fall, 1964 to better TV reception with the

BLONDER-TONGUE VAL·U·RAMA

How TV signal amplifiers improve reception

by Ben H. Tongue
(President, Blonder-Tongue Laboratories)

TV amplifiers can improve TV reception in many cases. There are, however, situations where no improvement is to be expected. This article will cover both situations to help you recognize potentially profitable installations.

Amplifier performance is determined by the level of internally generated noise (snow), amplification level, and degree of freedom from overload by strong local signals. Amplifiers are used as follows:

1. INCREASE CONTRAST Low cost TV sets generally have insufficient gain for weak signal reception. Old TV sets (low or high cost) often have aged tubes and insufficient gain. Low gain generally is the cause of poor contrast on weak signals. If the contrast of "snow" when the TV set is operating at full gain (no signal input) is much less than picture contrast on a strong signal, low gain is at fault.

A good amplifier, indoor or outdoor, will improve poor contrast caused by low gain. Contrast is reduced if the transmission line from antenna to TV set has a high loss. Noise (snow) is also increased by this condition. Let us assume that a good antenna is well installed and that quality transmission line is used (flat twinlead for VHF and round foam-filled twinlead for UHF).

TABLE 1 FREQUENCY	Length for 3db Loss	
Low Band VHF (Ch 3-6)	50′ Wet	300′ Dry
High Band VHF (Ch 7-13)	26′ Wet	158′ Dry
Low Half UHF (Ch 14-48)	45′ Wet	90′ Dry
High Half UHF (Ch 49-83)	37′ Wet	74′ Dry

2. REDUCE SNOW Snow appears when the TV signal-to-noise ratio is reduced. A good antenna reduces snow because of increased signal pickup. Transmission line loss increases snow because it reduces the signal reaching the first amplifier stage (booster or tuner RF stage). This reduces the signal-to-noise ratio. Here's how snow can be minimized:

a. Increasing signal pickup by using a higher gain antenna.

b. Using an amplifier which generates less noise than the TV input stage.

c. Amplifying at the antenna. If the amplifier has the same noise figure as the TV set tuner, the amplification overcomes transmission line loss, and the picture signal-to-noise ratio is nearly the same as if the TV set were at the antenna.

Point "A" applies at all times. Point "B" generally applies to low cost (tetrode tuner) and older TV sets when the amplifier is mounted near the set. Point "C" applies when the transmission line loss is appreciable. (See table 1). In this case we can improve the initial signal-to-noise ratio by using a low noise mast-mounted amplifier.

3. OVERCOME SPLITTING LOSSES Splitting a signal to drive several TV sets causes loss to each set. If the signal power is divided among two sets, each will receive ½ the original power (3db loss). This is equivalent in points "1" and "2" to an extra 3db of transmission line loss. The solution is amplification before splitting. This can restore contrast and re-establish signal-to-noise ratio (or even improve it).

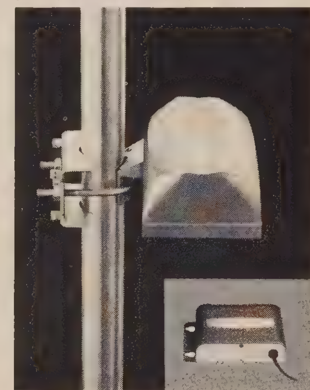
One transistor amplifiers are most susceptible to overload. Two transistor amplifiers are much less susceptible, performing about the same as single tube units. Two tube and dual section tube amplifiers overload least. Frame-grid tubes provide exceptionally low noise and last longer than ordinary tubes. If interference occurs, attenuation filters can be used.

Guide to selecting

BLONDER-TONGUE TV/FM SIGNAL AMPLIFIE

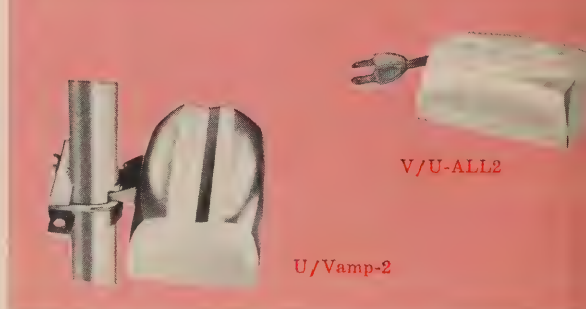
Brilliant color TV, sharp black and white TV and lifelike
stereo reception require strong, clean signals. To provide
viewers with the best possible reception in any area of
country, Blonder-Tongue offers the world's largest selec
of signal amplifiers. There are VHF amplifiers, UHF am
fiers, FM amplifiers. And, for the first time, all-channel
amplifiers covering every channel from 2 to 83.

When you select a Blonder-Tongue amplifier, you can alw
be sure of getting the best amplifier for your specific recep
problem. There are mast-mounted amplifiers designed to t
advantage of the best signal-to-noise ratio available at
antenna for weak signal areas. There are indoor amplifi
that offer convenient installation and can provide excel
results where there are relatively strong signals. You also h
a choice of either tubed or transistor amplifiers. For exam
transistor amplifiers offer greater gain and are most effec
in weak signal areas where there are no strong local chan
to cause overload.



The finest signal amplifier
the world are also the easie
install. Many of the m
mounted amplifiers feature
exclusive 'Miracle Mount'.
mast mounted amplifiers
ture a separate remote po
supply which can be insta
easily indoors near the set.
nally, secure, positive 300
connections can be made i
jiffy with Blonder-Tongue
tented stripless terminals.
The chart on the right h
page will serve as a guide t
will help you select the best
nal amplifier for your are

ALL CHANNEL



UHF

londer-Tongue amplifier that's best for you

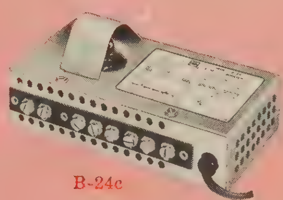
BLONDER-TONGUE SIGNAL AMPLIFIERS—VHF, UHF, VHF-UHF, FM

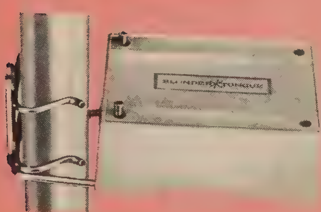
	MODEL	DESCRIPTION	COVERS CHANNEL	OUTPUTS	NET
MAST MOUNTED	U/Vamp-2	World's first mast-mounted UHF/VHF amplifier. 2 transistors. Built-in FM filter. Remote AC power supply. Separate inputs for UHF and VHF. Single 300 ohm input at power supply accepts combined UHF/VHF twinlead.	2-83	1	$33.25
MAST MOUNTED	Vamp-2	Mast-mounted VHF amplifier. 2 transistors. Separate remote AC power supply. Strong overload handling capability. 2 or more sets.	2-13	2	$25.85
MAST MOUNTED	Vamp-1	Mast-mounted transistor VHF amplifier. Separate remote AC power supply. FM trap.	2-13	1	$17.10
MAST MOUNTED	Vamp-2-75	Mast-mounted 75 ohm VHF home TV amplifier system. 2 transistors. Uses coax cable. Single 75 ohm output can be split to 2 or more TV sets. Strong overload handling capability. Remote AC power supply. FM trap.	2-13	1 (75 ohm)	$29.55
MAST MOUNTED	AB-3	Deluxe, mast-mounted TV/FM amplifier. Low noise frame-grid tube. Can be used up to a mile from AC source. 75 and 300 ohm outputs.	2-13, FM	1 (75 or 300 ohms)	$78.50
MAST MOUNTED	ABLE-U2	Mast-mounted UHF amplifier. 2 transistors. Uniform response on all UHF channels. Remote power supply. Miracle Mount.	14-83	1	$26.95
INDOOR	V/U-ALL2	World's first indoor UHF/VHF amplifier. 2 transistors. FM filter. Single 300 ohm input accepts combined VHF/UHF twinlead. 2 sets.	2-83	2	$27.50
INDOOR	B-24c	Indoor VHF/FM amplifier. Uses high gain, low-noise frame-grid dual-section tube. 4 sets.	2-13, FM	4	$17.25
INDOOR	IT-4	Indoor transistor VHF/FM amplifier. Excellent interset isolation. Up to 4 sets.	2-13, FM	4	$19.95
INDOOR	B-42	Indoor VHF/FM using high gain, low noise, frame-grid tube. Up to two sets.	2-13, FM	2	$14.25
INDOOR	U-BOOST	Indoor tuneable UHF amp Frame-grid tube.	14-83	1	$17.35
INDOOR	HAB	Deluxe, indoor VHF/FM amplifier for professional home installations.	2-13, FM	1 (75 ohm)	$49.65
INDOOR	FMB	Indoor FM amplifier. Ideal for stereo and regular FM. Uses frame-grid tube.	FM	1	$14.55

VHF

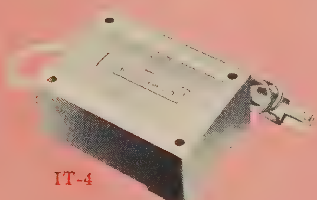

Vamp-2-75

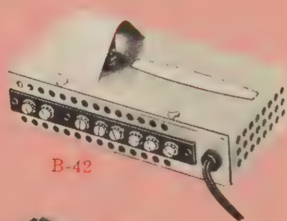

HAB


B-24c

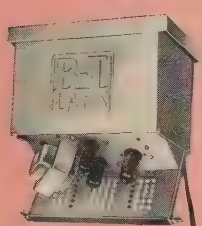


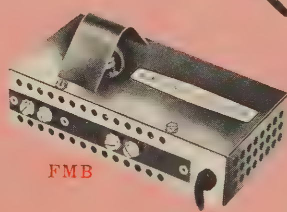
Vamp-1


IT-4


B-42


Vamp-2

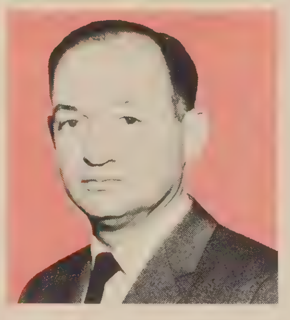

AB-3


FMB

UHF converter and antenna guide

Selection of right converter and antenna critical for UHF

by I. S. Blonder
Chairman of the Board,
Blonder-Tongue Laboratories, Inc.



There has been a long-standing prejudice against UHF. Since the band opened in 1952, many otherwise knowledgeable technicians have considered UHF reception to be inferior to VHF. Yet the recent New York City tests conducted by the FCC have proved that this is simply not so.

There is a reason for this paradox — equipment. In 1953, the state of the UHF art was relatively primitive. Today, experienced manufacturers like Blonder-Tongue are able to produce equipment capable of providing UHF reception that is, in many ways, superior to VHF.

The latest advance in UHF converters is solid-state circuitry. The use of transistors and tunnel diodes insures longer-life and generally lower noise figures. Also, the Blonder-Tongue patented tuners provide pinpoint, drift-free tuning. The result is brilliant color pictures and sharp black and white reception.

As for antennas, UHF has a definite advantage over VHF. Because the UHF wavelength is so small, high gain, efficient antennas are small and cost little. The periodic principle proved so successful in the U.S. Satellite program is especially applicable to UHF. The Blonder-Tongue Golden Dart (outdoor) and Golden Arrow (indoor) antennas utilize this priniciple.

While they are compact, these antennas provide more gain than the large VHF yagis. What's more important, their patterns are clean, rejecting unwanted "ghost" signals. With a little extra care in selecting and installing UHF equipment, you can often provide your customers with better UHF pictures than they've been watching on VHF.

Blonder-Tongue UHF converters

These all-channel UHF converters, your best investment in TV enjoyment, add channels 14-83 to your present set. They are particularly suited to meet the critical demands of color TV. The new BTX-11 and BTX-99 converters retain traditional Blonder-Tongue features such as peak performance on all UHF channels, easy installation and reliable, long-term operation. To these well-known features have been added the advantages of all-transistor circuitry; maximum stability for drift-free performance and lower noise figure for snow-free reception. The BTD-44 employs a tunnel diode circuit for excellent, low cost battery operation.

Blonder-Tongue UHF antennas

The UHF antennas are designed to match the high performance standards on all UHF channels of our famed UHF converters. They employ the well-known Periodic principle, to provide uniform, high gain across the entire UHF spectrum for sharp, ghost-free pictures. Full bandwidth makes these UHF antennas excellent for color and black & white TV.

The Golden Dart is an outdoor UHF antenna which comes completely pre-assembled with nothing to snap out, no screws to tighten. The Golden Arrow is an indoor UHF antenna, which outperforms all other available indoor UHF antennas.

ALL-CHANNEL UHF CONVERTERS

DESCRIPTION	EFFECTIVE RECEPTION RANGE*	INPUT CHANNELS	OUTPUT CHANNELS	NET
BTX-11 — Deluxe all-channel, all-transistor UHF converter/amplifier. Adds all UHF channels to any set. Triples TV signal strength. Easiest tuning with dual-speed channel selector.	Used with an outdoor antenna anywhere up to 50 miles from station. With indoor antenna, up to 25 miles.	14-83	5 or 6	$31.20
BTX-99 — All-channel, all-transistor UHF converter. Adds all UHF channels to any set. Provides maximum signal power. Drift-free, distortion-free.	Can be used with indoor antenna for prime signal areas and outdoor antenna up to 25 miles from station.	14-83	5 or 6	$19.85
BTD-44 — All-channel, tunnel diode UHF converter. Utilizes tunnel diode for maximum reliability. Operates on ordinary flashlight battery which lasts from 6 to 9 months.	Can be used with indoor antenna for prime signal areas and outdoor antenna up to 25 miles from the station.	14-83	5 or 6	$13.20

ALL-CHANNEL UHF ANTENNAS

DESCRIPTION	EFFECTIVE RECEPTION RANGE*	FRONT-TO-BACK RATIO	NET
GOLDEN DART outdoor UHF antenna Uses Periodic principle, 11 working elements for uniform high gain across the entire UHF spectrum.	Up to 50 miles.	20db min.	$3.55
GOLDEN ARROW indoor UHF antenna Employs 10 working elements to provide constant high gain and matched impedance. Full Bandwidth — flat response.	Up to 20 miles.	20db min.	$2.70

*In weak signal areas, use a model Able-U2 UHF amplifier.

ENJOY BETTER TV RECEPTION WITH BLONDER-TONGUE.

SAVE DURING THE VAL-U-RAMA NOW GOING ON.

BLONDER-TONGUE
9 Alling Street, Newark, New Jersey 07102
Canadian Div.: Benco Television Assoc., Ltd., Toronto, Ont.
home TV accessories • closed circuit TV • community TV • UHF converters • master TV

FLYING SAUCERS - MYTH OR FACT?

. . . Why the Recently Increased Belief in Unproved Phenomena? . . .

Since the airplane has become universal—and long before that—people all over the world have been exceedingly interested in atmospheric and optical sky phenomena. An unbelievable, almost religious, fervor has arisen on the controversial subject of flying saucers.

One would think that only the credulous would be caught in such a trap. Not so. Many semiprofessionals, highly intelligent students, airplane pilots on oversea runs, ministers, amateur scientists, newspaper columnists and scores of others have "observed" and even photographed these phenomena regularly and reported on them in depth in the press all over the world with increasing frequency. For 20 years, we have never given a talk without being questioned about the possibility of flying saucers.

In spite of the protests of serious scientists about their existence, the subject of flying saucers is very much in the public mind and interest seems to be increasing.

Even the Air Force keeps track of most of the reported saucer sightings, and usually has very good explanations for all but 2.09%, which are admittedly unexplained, according to a *Newsweek* report of March last year.

These are usually called UFO's—*Unidentified Flying Objects.* The abbreviation is now even a good dictionary term.

There are scores of UFO associations and clubs all over the map, such as the British UFO Association. One New York magazine editor who publishes a flying-saucer monthly even wants a world UFO association.

Then there is a rabid believer in England who never gives up—Antoni Szachnowsky, erstwhile from the 2nd Polish Corps in 1945, who organized a 300-member Anglo-Polish UFO Research Club. It was he, also, who founded the British UFO Association.

How many people have been initiated into the Flying Saucer Club? While no trustworthy statistics exist, from all the evidence we have gathered from many sources, there certainly must be millions.

One sure evidence can be found in the hundreds of books on flying saucers, particularly in Europe, behind the Iron Curtain and in the United States.

There is little point in contradicting the gullible and overcredulous. This world-wide literature is too easy and too good a money-maker for a certain type of unprincipled publisher, motivated only by fast trash sales.

Why do people believe in this extraordinary, unscientific cult? On both sides of the Iron Curtain the fixed belief is that "the Enemy" is the greatest culprit. Both sides are convinced that we spy on each other continuously via the flying saucers.

Those a little more sophisticated—or more romantic—feel certain that the UFO's are extraterrestrial, come from our own solar system or originate from neighboring stars.

Now let us for a minute apply ordinary science logic to these arguments, and reason why, despite its long history and its cult following of millions the flying saucer just won't stand up.

1. While thousands of airplanes have been shot up and brought down, while hundreds of others have been wrecked in accidents and destroyed and the evidence found—*not a single flying saucer has ever been shot down, nor has one accidentally been destroyed, grounded or ever been found.* These facts are significant.

2. In these days of electronic progress, no verifiable radar echo has ever been recorded against a flying saucer. Yet in many of these so-called sightings the objects were reported as being certainly much less than a hundred miles distant. But we have no difficulty in getting radar echoes from the moon, 238,000 miles away, or even from Venus, more than 40 million miles distant.

3. Some people insist that UFO's have indeed been recorded, and cite as evidence the unexplained blips on radar screens that used to be called "angels." But there has been no report of "angels" being coincident with sightings of UFO's—indeed there was such a lack of obvious visible cause that for a time it was believed that angels were produced by discontinuities between cold and warm layers of air. More recently, the discovery that "angels" are produced by flocks of migrating birds pulled the carpet entirely out from under the proponents of the flying-saucer theory.

Another significant point: If a flying saucer from any point in the solar system were to visit the vicinity of the earth, the pilots or operators would necessarily have to keep in contact with their own world. Let us assume, too, that these creatures are far ahead of us. They would have to use some sort of electromagnetic communication—radio, optics (such as lasers), etc. Yet we have never yet intercepted such signals, despite our advanced search radios, our radio-astronomy observatories and our sensitive optical observatories. Why? Because flying saucers are a myth; *they just do not exist—so far.*

Instead of reading romantic nonsense or fantastic science fiction, people might well read the outstanding scientific book on this controversial matter: *Flying Saucers,* by Dr. Donald H. Menzel, of Harvard College Observatory, Harvard University. Says its foreword:

". . . of the natural origins of flying saucers from mirages and sundogs all the way back to Ezekiel's wheels in the Bible.

"In this book a top-flight scientist who has seen many a so-called flying saucer himself explodes every one of the current myths about their nature and origin. People who like to be scared or mystified may not want to agree with what Dr. Menzel has to say—but everyone who wants to know the real answer will find it in these pages. And the answer banishes forever the 'little men,' the foreign power's guided mis-

continued on page 92

This Transistor Voltmeter Has High Input Impedance!

A single field-effect transistor is the key to this meter's 11-megohm input resistance. Completely portable

By DAVID L. PIPPEN

One of the most promising applications of the unipolar field-effect transistor (fet) is in portable equipment that requires a high input impedance—like a voltmeter. Since the fet has essentially the same general characteristics as a vacuum tube—high input resistance and moderate output resistance, it should compete readily with vacuum tubes in high-input-impedance voltmeters. The dc fet voltmeter or fetvm described here is a compact, dependable instrument of moderate cost. Its input resistance is approximately 11 megohms, and it measures dc from 1 to 1,000 volts full scale.

Fig. 1-a shows a bar of silicon that has been doped with an n-type impurity. On each side of the bar, p-type impurities have been introduced to form a p-n junction on each side. The p-type materials on either side of the bar are connected to form a single connection. One end of the bar is the *source;* the other end, the *drain.* The center connection is called the *gate.* This device is called an *n-channel* fet.

A *p-channel* fet can be constructed if the bar is doped with p-type material and the center portion doped with n-type material, as shown in Figure 1-b.

A p-channel fet is biased as shown in Fig. 2. Notice that the gate bias supply is connected to *reverse-bias* the p-n junction formed by the p-type bar and the n-type gate. Notice also that the battery connected from source to drain allows current to flow through the bar. With the gate disconnected as in Fig. 2-a, this current is limited by the resistivity of the bar and the load, R_L. Reverse-biasing the gate causes the input circuit (gate to source) to have a very high resistance (as in a reverse-biased junction diode).

With a small gate battery connected (Fig. 2-b), the current flow through the bar decreases due to the enlarged depletion region around the p-n junction (represented by the cross-hatched area). Should the gate voltage be increased much more, the depletion regions formed on each side of the bar merge as in Figure 2-c. This condition allows no current to flow through the bar. The gate voltage that cuts off the current through the bar is called the *pinchoff voltage.*

So the fet, like the vacuum tube, is a normally on device that requires a gate voltage of proper polarity to turn it *off*. Since the input circuit is a reverse-biased p-n junction, its resistance is high. Fet's are now on the market with input resistances in the order of 100 *gigaohms* (1 gigaohm = 10^9 ohms).

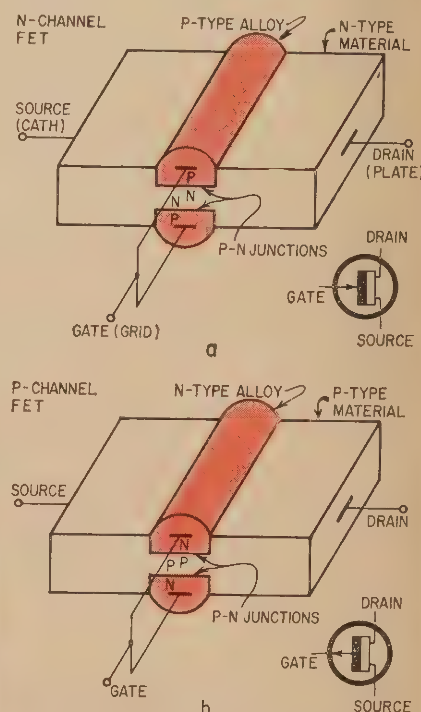
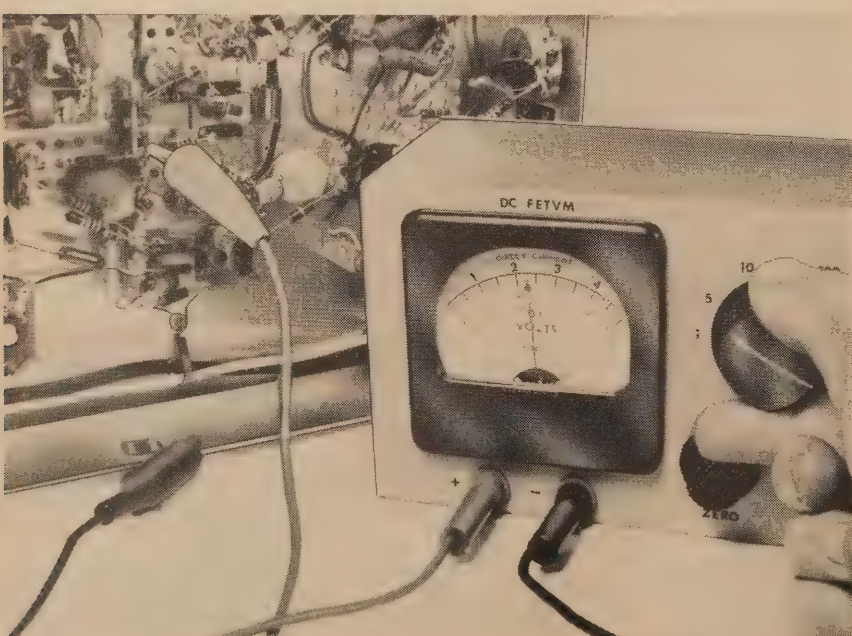


Fig. 1—The two kinds of field-effect transistors and their schematic symbols.

The field effect transistor voltmeter in action



Two outstanding advantages of the fet over vacuum tubes are that it requires no filament power and that there is a choice of polarities—either a p-channel or n-channel device may be selected. The p-type fet requires a negative drain-to-source battery and a positive gate-to-source voltage to pinch off drain current. The n-type fet is the opposite.

BENCH TESTED

A RADIO-ELECTRONICS editor, who used the instrument for a time, reports: "This meter works very well and compares favorably with a vtvm. Accuracy was good on all ranges, except that the 10-volt range seemed to indicate a little high. Perhaps a value of 750,000 ohms would be better [as R11].

"Drift is negligible, readings are stable on all ranges."

The usual vtvm differential amplifier circuit requires two active elements—two triodes, transistors or fet's. Since most commercial fet's are relatively expensive at this time, a two-battery circuit was chosen for economy. It needs only one fet.

A 100-μa, 1,900-ohm meter-movement was used as the voltage indicator and two 9-volt transistor radio batteries for the power supply.

Fig. 3 is the schematic of the dc fetvm. BATT 1 causes upscale current to flow in the meter. BATT 2 is adjusted to offset this current flow. Thus the meter is balanced and the pointer reads zero. A negative voltage on the gate causes the fet to conduct more, upsetting the balance. The meter pointer moves upscale. Switch S1 is the range selector. R5 is the gate return resistor, and the .01-μf capacitor C shunts ac pickup from the gate circuit.

You have probably noticed the unconventional input attenuator circuit used in the fetvm. A much higher input resistance can be obtained with the conventional fixed-value, tapped-divider arrangement, but the balance pot will have to be readjusted each time the range selector is switched. More expensive fet's would probably alleviate this problem, but several 2N2386's tried in this circuit all acted the same.

These fet's had sufficient minority current flow in the p-n junction to make the gate bias change slightly when the gate return resistor was changed. This in turn caused the drain current to change and the pointer to move off zero. Placing isolating resistor R6 between the gate and the attenuator network eliminated that. This lowered the input resistance, but it is still approximately 11 megohms (equal to that of service vtvm's).

Should you want a higher input resistance, a 50-μa, 2,000-ohm movement can be used in the same circuit. This will allow input resistor R13 to be increased to 22 megohms.

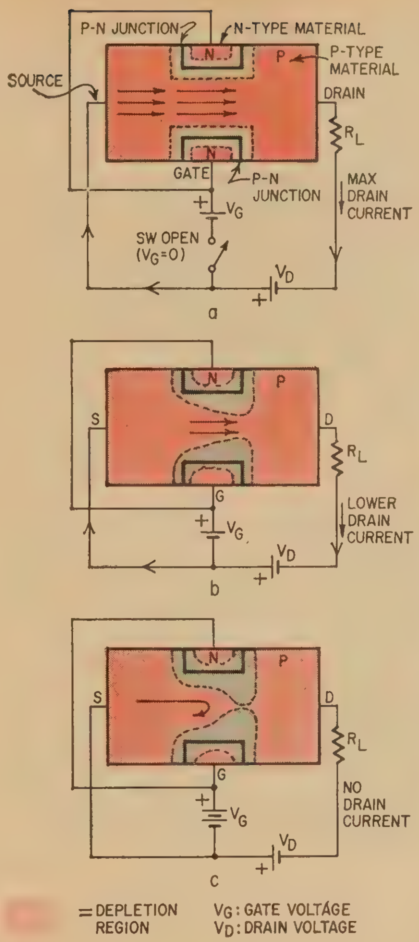
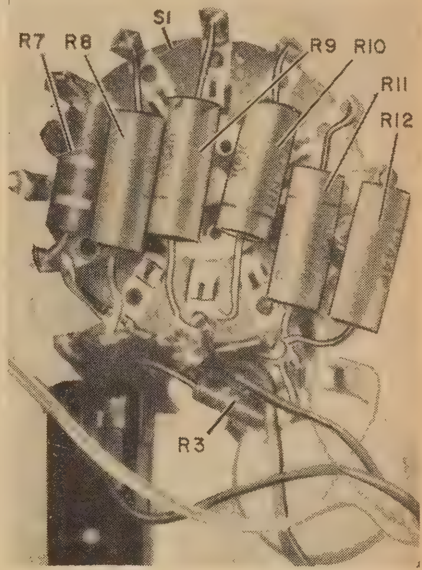


Fig. 2—A p-channel fet and how it is controlled from saturation to cutoff. In (a), the gate voltage is zero and current flows unimpeded through channel from source (S) to drain (D). In (b), small reverse bias between gate and channel sets up electric field that tends to "pinch off" current flow. In (c), gate field is great enough to pinch off channel current completely. Because gate is always reverse-biased, no current flows in gate circuit and fet's input resistance is very high.



How the switch is wired

Putting it together

Construction is simple. No special layout is required. Any meter movement with similar resistance and sensitivity will probably work as well as the one used in this circuit.

Multiplier resistors R7 through R12 should be within 1% of the value indicated. (R7 and R12 can be made up of two resistors in series to obtain the correct total.) The chassis is a Bud AC-430 which measures 4 inches deep by 6 inches wide by 3 inches high. A

BATT 1, BATT 2—9-volt "transistor radio" battery (Burgess 2U6 or equivalent)
C—.01 μf, ceramic, 50 vdc (or higher)
J1, J2—banana jacks or binding posts
M—100-μa meter movement, 1,900 ohms (Simpson model 27 or equivalent)
Q—2N2386 field-effect transistor (Texas Instruments)
R1—pot, 5,000 ohms
R2—pot, 2,000 ohms
R3—10,000 ohms
R4—430 ohms
R5—22 megohms, 5%
R6—200,000 ohms
R7—7,200 ohms
R8—15,000 ohms
R9—75,000 ohms
R10—150,000 ohms
R11—820,000 ohms
R12—1.75 megohms
R13—10 megohms
R14—1 megohm
Resistors R6 through R14 inclusive are 1% tolerance. All others may be 10% except R5.
S1—single-pole, 7-position shorting rotary switch (Centralab 1000 or equivalent)
S2—dpst toggle switch
Case or chassis (see text)
Terminal boards or strips; miscellaneous hardware

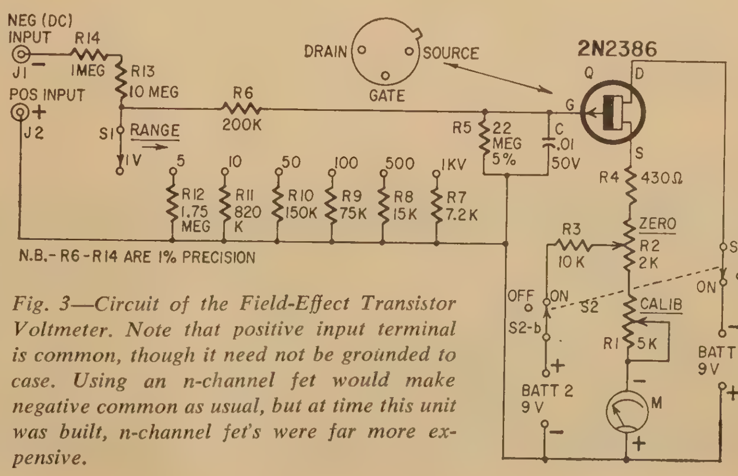
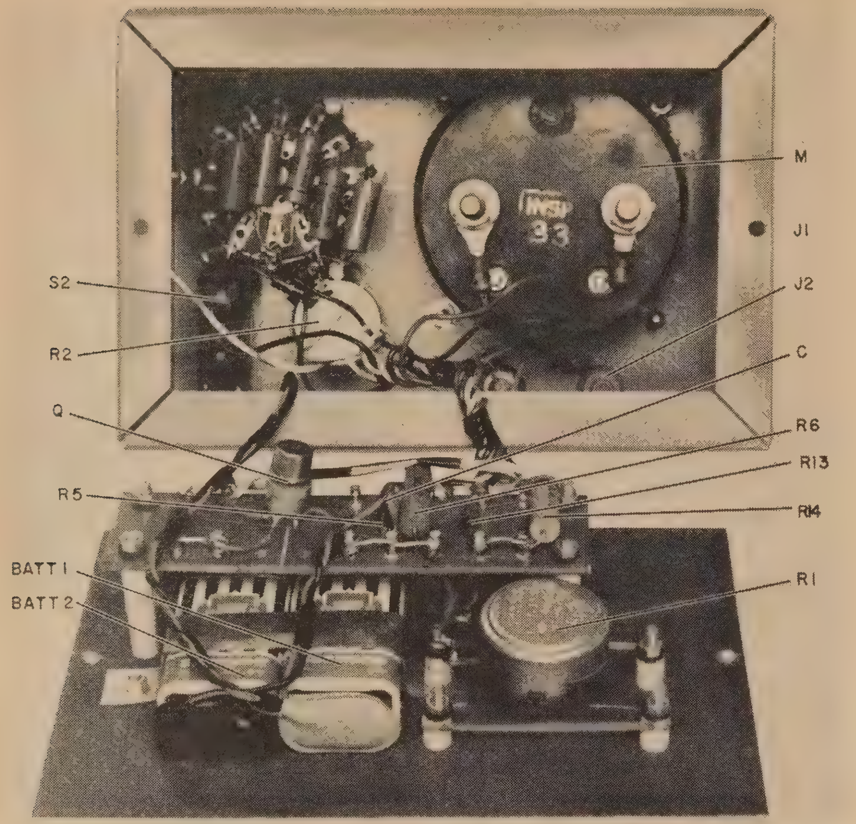


Fig. 3—Circuit of the Field-Effect Transistor Voltmeter. Note that positive input terminal is common, though it need not be grounded to case. Using an n-channel fet would make negative common as usual, but at time this unit was built, n-channel fet's were far more expensive.



Rear view of meter, with all components

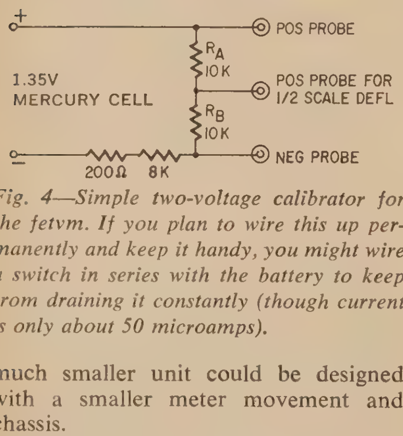


Fig. 4—Simple two-voltage calibrator for the fetvm. If you plan to wire this up permanently and keep it handy, you might wire a switch in series with the battery to keep from draining it constantly (though current is only about 50 microamps).

much smaller unit could be designed with a smaller meter movement and chassis.

Texas Instruments sells a line of germanium fet's that are much cheaper than the one used in this meter (the TIX-880 to -883) and perhaps would work as well in the circuit given. They sell for less than $3.

The 100-μa meter face was modified slightly. A typewriter eraser was used to erase the original "microamperes" using 12-point press-on type letters such as Datak sold at electronics, art and blueprint supply houses. The 0–5-volt scale and the meter case were also lettered with the Prestype.

The component board, the two batteries and the balance potentiometer were mounted on the back panel. The balance pot was mounted so that it could be adjusted without removing the back. The back panel was made from ⅛-inch-thick aluminum, cut to fit the dimensions of the chassis.

Calibration is also very simple. Fig. 4 shows a voltage-divider network, used with a 1,35-volt mercury cell to make an accurate calibration source.

1. Set range switch S1 to the 1-volt position. Adjust calibrate pot R1 to maximum resistance.

2. Switch the fetvm to on.

3. Short the probes together and adjust the balance control for zero meter reading.

4. Place the probes across resistors R_A and R_B (Fig. 4).

5. Carefully adjust calibrate potentiometer R1 for full-scale deflection.

6. Remove the probes from the calibration source, short them together and adjust the balance control for zero meter reading.

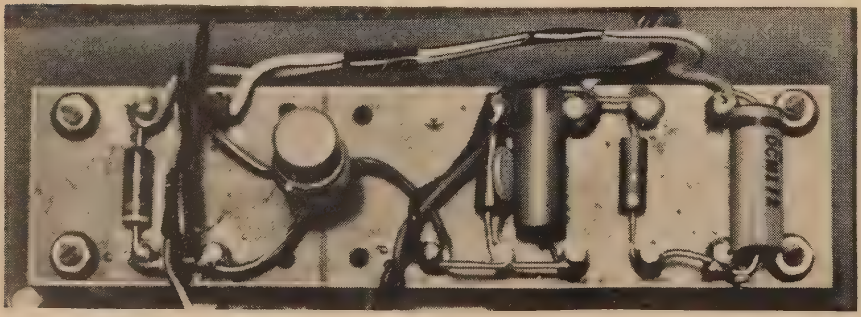
7. Repeat steps **4** and **5.**

8. Place the probes across R_B. The meter should now read half scale.

The completed instrument is accurate to within 1% of full scale for measurements within the upper two-thirds of the scale. It is stable and zero-drift is no problem.

Remember that there is no "on" indication light and that the instrument draws current even when the meter is zeroed. Therefore, be sure to turn the instrument off when it is not in use. END

Close-up view of the component board



Yoke-Checking: The Finger Method

YOU CAN DETERMINE EASILY WHETHER A TV set's yoke is defective without removing the chassis. Just take its temperature with your finger!

If you discover that a set has no B-boost voltage, you might suspect a shorted horizontal winding in the yoke. If you could establish that in the customer's home, without pulling the chassis, you'd be ahead by a bit. Remove the yoke from the CRT neck but leave it connected. Lay it on or near the chassis where it won't short accidentally against some other component.

Plug the power cord into the set, turn the set on and let it cook for 2 or 3 minutes. Disconnect the cheater and feel around inside the yoke windings. If you find a hot spot, the yoke windings are shorted internally.

Never touch the yoke with power applied to the chassis!

You may want to go one step further to prove definitely that the yoke is defective. Disconnect one of the wires to the horizontal windings. This takes them out of the flyback circuit. Now check the boost voltage. It should be back to normal, or possibly slightly higher than normal, since the yoke is normally a load on the horizontal deflection circuit.—*G-E Service Talk*

Case of the BUILT-IN MOTORBOAT

By HUGH KENNER

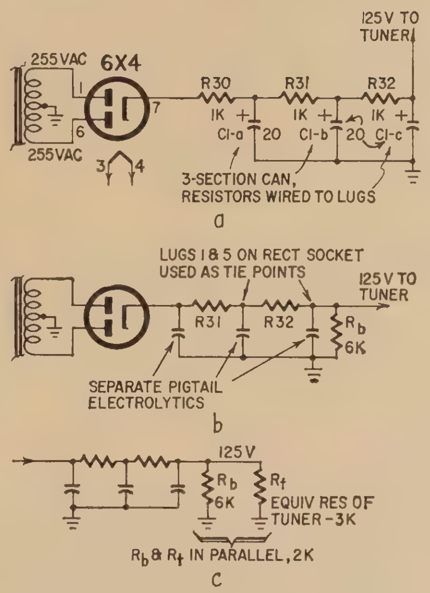
THE COMPLAINT WAS MOTORBOATING, but not right away. For the first hour you just heard the music, but after that you couldn't hear anything but the noise. It sounded like someone with a fast hammer was inside the speaker cabinet. Only on FM: that pointed to the tuner—a Bell, model 2520. Had it ever given trouble before? Yes, the same trouble, a couple of years ago. A ten-dollar service call had driven it away. Now it was back. In fact it had come back very quickly. They'd been living with it for months. Could I, as a friend, suggest something?

Before the back was off the wooden enclosure, I was able to suggest that we fry some eggs. The wood was hot to the touch a foot back of the tuner, despite large ventilating holes. The tuner itself was too hot to move. When I finally got its cover and bottom plate off, discolored metal around the power supply filter showed where to start checking. A shorted electrolytic, probably, and the others had finally quit from overheating? I took the tuner home for surgery.

Then I got my first surprise. The factory electrolytic, a three-section can type, wasn't in the circuit at all. It was probably the one that had stopped working 2 years ago (a quick check showed that it certainly wasn't operable now), and the repairman hadn't bothered to find a replacement. Instead he had wired in three separate pigtail sections under the chassis. That had meant, of course, new tie points for the three resistors, R30, R31, R32 (Fig. 1-a). They had formerly been wired to the lugs on the capacitor can. With the schematic open in front of me, I started the 2-minute job of identifying them.

Surprise two: R30 was nowhere to be found! C1-a went to ground directly from pin 7 of the rectifier. Yet there were still three big power resistors in sight, and—surprise three—they were all of them tied to pins on the rectifier socket. What was more, one of them, a 6,000-ohm unit, seemed to lead off to ground. A few minutes' work with ohmmeter and pencil, and my scratch pad had a new drawing (Fig. 1-b).

When those pigtail capacitors went in 2 years ago, the unused lugs on the



rectifier socket became tie points. Good enough. But a 6X4 has only two unused pins (2 and 5), whereas the circuit needs three. So Mr. Lazybones had simply eliminated R30, and coped with the resulting excess B-plus by running a bleeder to ground (R_b, Fig. 1-b). Unlike a series resistor, a bleeder doesn't need an additional tie point.

Reflecting dimly on the implications of this bleeder, I commenced restoring the circuit to the form in which it had left the design table: a mounting screw for a new tie point, R30 restored, R_b out. Then I turned the tuner on and did a little arithmetic while it warmed up.

Approximately 40 volts was being dropped across R30. So the circuitry drew 40 ma. Each of those three resistors drew I^2R, or $.04 \times .04 \times 1{,}000$ watts, 1.6 watts apiece, a total of 4.8 watts of heat dissipation under the chassis.

Now what happens when we drop R30 and add the bleeder? Let's suppose Mr. Lazybones asked himself that 2 years ago. Maybe he worked it out like this. The bleeder drops the full B plus to ground: 125 volts across 6,000 ohms: E^2/R, or 2.6 watts. And 1.6 watts apiece for R31 and R32, 5.8 watts total. Just 20% more than the design value. Give him this much credit: if he carried his figuring that far before reaching for the soldering iron, he saw no particular risk. One extra watt won't cook anything.

But: although that bleeder gets the B-plus down to the 125 volts the designer ordered, it brings it down by dragging extra current through the source impedance. The power supply doesn't know whether it's feeding an FM tuner, a load resistor or a moustache curler. To a source of dc, everything that draws current feels like a resistive load. The tuner (which draws 40 ma, remember?) feels like a 3,000-ohm load across that 125-volt source. Add the bleeder, and you've got another 6,000 ohms in parallel with that (Fig. 1-c). 6K and 3K in parallel, equivalent resistance 2K. 125 volts through 2K, 62.5 mils. That's 50% more current than before. And the heating effect rises with the square of the current.

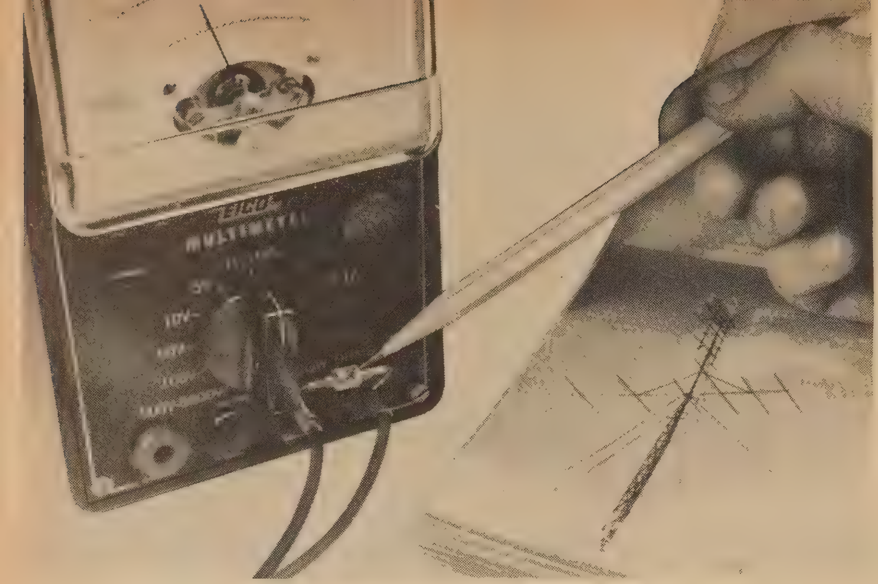
So now R31 and R32, with 62.5 ma through them, are drawing 4 watts apiece, or 8 watts; and 2.6 watts for the bleeder, 10.6 watts, more than twice what we had before. And that's just resistor heating. Don't forget that the source impedance through which that extra current is dragged includes the transformer.

By the time the heat from its windings has soaked up through several pounds of metal, the transformer, even under normal conditions, is radiating more heat under the tuner cover than all the circuit resistors put together. And once again, heat increases as the square of the current. Raising the current from 40 ma to 62.5 increases the transformer heat 2½ times. Did Mr. Lazybones say something about a mere 20%?

From the moment the "doctored" tuner was turned on, we were getting twice as much resistor heat as the design called for, and within a hour, more than twice as much transformer heat. Under a pancake cover, where heat circulation is figured pretty closely, all that extra heat was cooking the electrolytics, raising their series resistance, while the power supply's ac impedance crept up and up. Hence the motorboating, built in, inevitably built in, by a technician who thought he was curing it for good and saving himself work at the same time.

When I went back to the tuner, it was running as cool as you please. Six hours later it was still cool. Three months later it's still in daily service. I never did have to replace those electrolytics. Just getting their ambient temperature down to something reasonable was all they wanted to work perfectly.

Very likely none of it would have happened if the rectifier had been a 5Y3. Mr. Lazybones would have found another tie point on the socket! END



10 Ways To Get More Use From Your VOM and VTVM

By WAYNE LEMONS

None of us use the common pieces of test equipment as much as we would if we had some simple accessories to go along with them. Most of us would probably build these accessories if they didn't require too much time or special parts. Here are some simple plans for equipment that can be built in an hour or so and that can save you many precious hours in service or experimental work. At the end is the plan for a device that combines four of the simple devices into one enclosure and gives you a special instrument you can use on several kinds of jobs.

1. Field Strength Meter

With today's widespread use of two-way radio we often need some way of telling whether a transmitter is working, judging its relative output power and peaking the antenna circuit. A single diode (1N34, 1N64, etc.) will

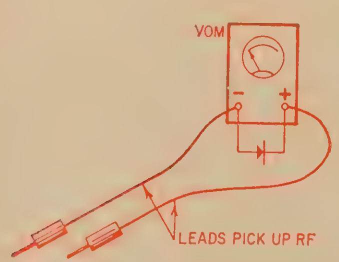


Fig. 1—Diode across meter leads rectifiers rf. Use dc range.

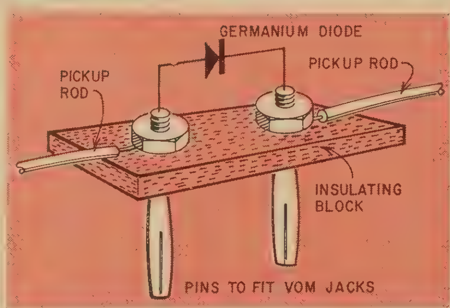


Fig. 2—More permanent and useful adpater for rough rf checks. Rods can be cut to resonate.

turn your vom into a portable field-strength meter (Fig. 1). The test leads act as a pickup antenna. If you want a more elaborate and slightly more satisfactory device, Fig. 2, shows one that plugs into your meter instead of the test leads. The rigid mounting of the pickup antenna is better since the wires will be suspended in space symmetrically and provide somewhat better accuracy, especially when making relative output measurements from one transmitter to the next.

The length of the pickup antenna is not critical though output will be higher if each antenna rod is cut for the frequency desired.* For lower frequencies, use the circuit of Fig. 3 if you need more sensitivity. Use your vom on direct current or voltage ranges, depending upon the sensitivity you need.

*Quarter wavelength in inches $= \frac{2770}{F_{mc}}$

2. Checking CB power output and modulation

You can use either your vtvm or vom for this. Build the circuit of Fig. 4 into a small metal box. Be sure to use 2-watt *carbon* or other noninductive resistors. This circuit makes an ideal dummy antenna capable of safely absorbing the 2½ to 3½ watts of rf output encountered in CB transmitters. By

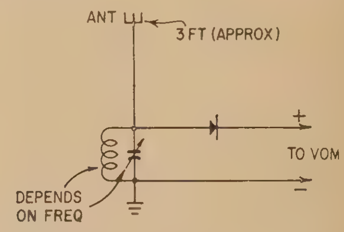


Fig. 3—Simple field-strength meter.

tapping off with the diode as shown, and using your vom or vtvm on DC VOLTS, each volt reading will indicate approximately 1 watt of antenna power. For example, a reading of 3 volts means that the transmitter is capable of radiating approximately 3 watts of power from a properly matched antenna system.

For making relative modulation checks, speak into the microphone while watching the meter. The power output should *increase* about 22½%. This is called *upward* modulation. If power output decreases (downward modulation), something is wrong with the transmitter.

3. Read alternating current and power

Most vom's or vtvm's make no provision for reading alternating *current,* though often that would be a help. Fig. 5 is a simple way of making such readings. Built into a small box with ac connectors, it is easy to use and no disconnects have to be made.

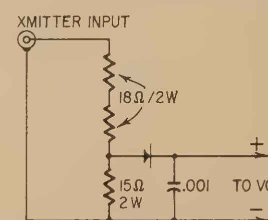


Fig. 4—CB wattmeter taps off small rf voltage from 51-ohm dummy load.

One-ohm resistors are not hard to find. Unless current is extremely heavy, the voltage drop will not affect operation, yet can be measured easily. With a 1-ohm resistor there will be 1 volt drop across the resistor for each ampere of current.

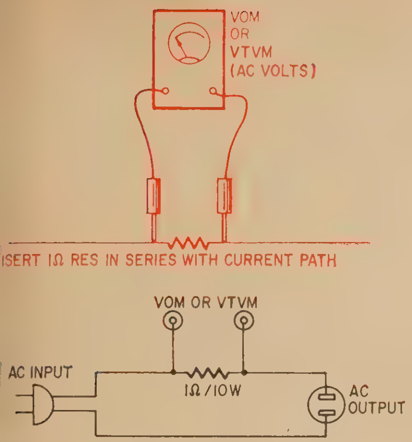


Fig. 5—To measure current, insert 1-ohm resistor in circuit and measure drop across it.

Ac power in watts is a product of volts times amperes if the circuit has a power factor of 1. TV and radio devices are close enough to unity power factor—for all practical purposes the wattage equals the voltage across the load multiplied by the current through it.

4. A resonance checker

How often have you picked an old i.f. transformer out of your junkbox and wondered if it was still OK and whether it was tuned to 262 kc, 455 kc, or some other frequency? Fig. 6 shows different methods of finding out just by using your signal generator and vtvm.

In Fig. 6-a capacitor C should be as small as will still allow a usable deflection on the meter. Since this capacitor is effectively in parallel with the resonant circuit, too large a capacitor will cause an erroneous reading. For i.f. and broadcast frequencies, a 10-pf capacitor is about right, since it will simulate the actual stray capacitances in the circuit when the transformer is wired in. For higher frequencies the capacitor may be reduced.

Fig. 6-b shows an alternate method. The low generator impedance will "swamp" one winding but the other should "peak up". Reverse the transformer to check both windings.

Fig. 6-c is for transistor i.f. transformers. In this case only one resonant circuit is used and the base (untuned) winding pretty well matches the output of the signal generator.

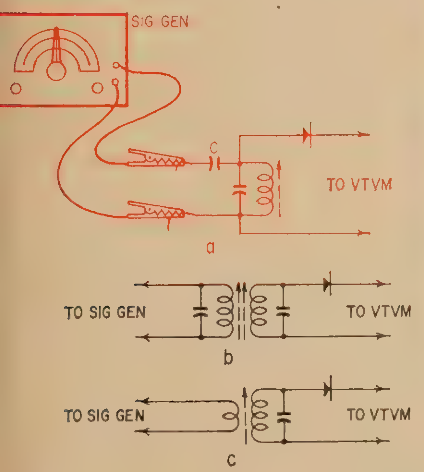


Fig. 6—Three ways of checking i.f. transformers. (a) shows a single winding being checked with signal applied through a small capacitor C. In (b), one winding of transformer couples signal to other—no capacitor. In (c), low-impedance base winding of transistor i.f. transformer couples test signal to tuned winding.

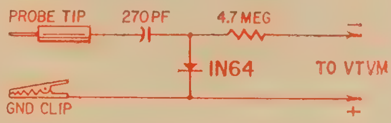
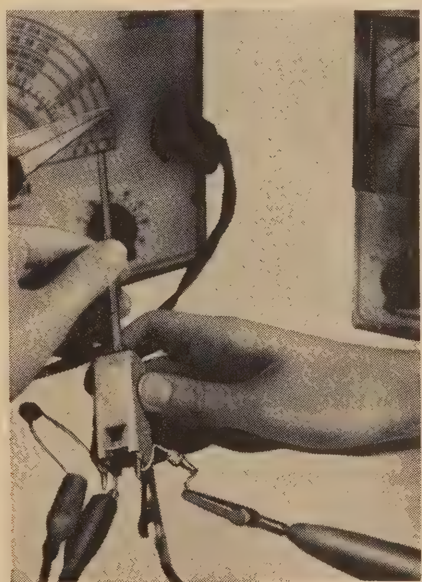


Fig. 7—Rf probe for vtvm. Build the whole thing into some kind of tubular shield.

If the transformer or resonant circuit is good, you should get a definite and pronounced peak on the meter when the signal generator is tuned to its resonant frequency. You can also get some idea about the Q of the circuit: a high-Q circuit will produce a sharper peak.



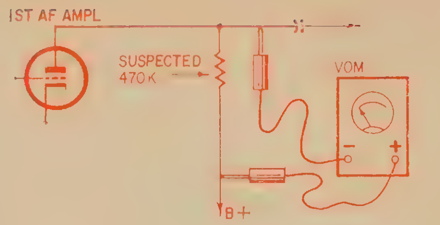


Fig. 8—A vom can be a resistor, where values are not critical.

Instead of the diode, you can of course use the rf probes supplied by many manufacturers for their vtvm's. Fig. 7 is the schematic of a commercial rf probe that uses an isolation capacitor to block dc from the diode. The diode is shunt-connected so that it will have a dc return path (otherwise broken by the blocking capacitor). The resistor isolates the cable capacitance from appearing across the diode. This kind of probe, if carefully designed, is useful to around 250 mc and loads the circuit little. You can build one like it in a miniature tube shield or other small probelike enclosure.

5. A resistance substitute

You don't have to watch a professional technician long before you see him use his vom as a temporary resistance substitute in a suspected circuit. A case in point might be distorted or weak audio output from a TV or radio. This kind of trouble often results from an open or changed-value resistor in the plate or screen circuit.

A 20,000-ohm-per-volt meter on the 50-volt range is a 1-megohm resistor (Fig. 8). You can get other values by simply rotating the range switch. This 1-megohm resistor will substitute for resistors within 200% or 300% of that value in audio circuits. Placing the meter across the suspected resistor may bring the sound back loud and clear and prove the trouble really is what was suspected.

A vom on its 500-volt range can determine whether the agc bucking resistor is open and causing a snowy picture. The resistor is usually in the neighborhood of 10 megohms.

Tricks such as this, intelligently used, are the difference between the mechanic and the artisan.

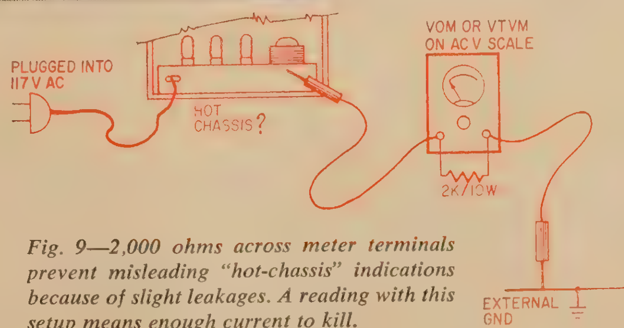


Fig. 9—2,000 ohms across meter terminals prevent misleading "hot-chassis" indications because of slight leakages. A reading with this setup means enough current to kill.

6. Checking "hot" chassis

With sensitive meters, we may find some voltage reading from a chassis to an external ground regardless of which way the ac plug is inserted. This is a case where we must "desensitize" the meter by using the circuit of Fig. 9. With this circuit, small, harmless leakages, such as through a 1-megohm resistor, will not register on the meter. But if there is enough leakage current to be lethal, the 2,000-ohm resistor will not affect the voltage reading.

7. Checking transistor radio drain

One of the single most important measurements in transistor radio servicing is battery current drain. Nearly any vom can be pressed into service here by using one of the devices of Fig. 10. Fig.

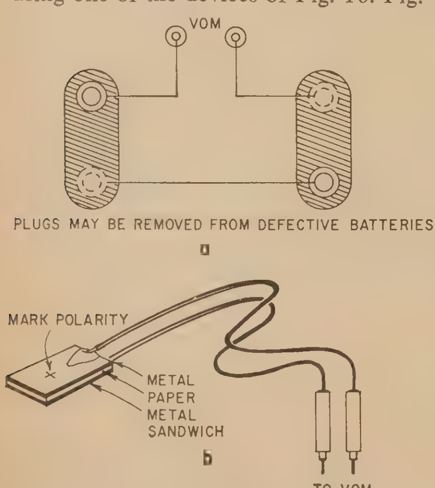


Fig. 10—Current-measuring adapters for transistor portable radios. The one in (a) is for 9-volt batteries with two terminals on one end; the one in (b) is for "flashlight" type cells.

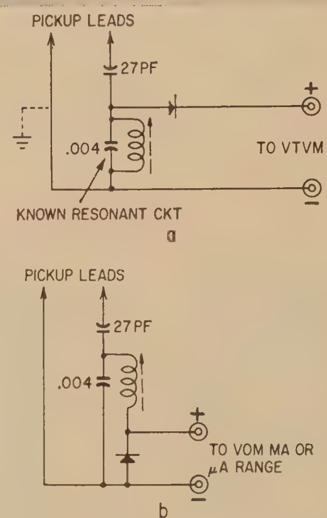


Fig. 11—Either of these circuits—(a) for vtvm, (b) for vom—can check whether a TV horizontal oscillator is on frequency.

10-a is self-explanatory. For Fig. 10-b, cut two pieces of thin metal ("shim stock" purchased at auto supply houses is ideal) separated by a strip of paper (glued in place) that overlaps the edges of the metal just slightly. Wires connected to the metal strips are used as meter leads. This device can be inserted between flashlight type batteries or between batteries and connectors so that the meter is in series and reads total current flow.

Some vom's have too much resistance for this job and can cause the radio to motorboat, but most meters are all right on current ranges of 100 ma or more.

8. Checking horizontal oscillator frequency

The circuit in Fig. 11-a or 11-b will let you check the horizontal oscillator frequency in a TV set. Actually, this circuit can be used for almost any low or medium frequency by changing the coil-and-capacitor combination. Here a regular 50-mh horizontal ringing coil is used.

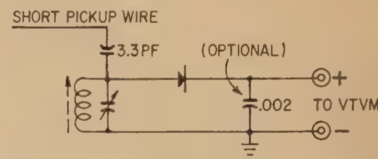


Fig. 12—This adapter "sniffs out" the local oscillator signal in AM radios. Is it there? The right frequency?

To check horizontal frequency, the circuit should first be calibrated using a operating TV with the picture locked in. Adjust the ringing coil for maximum meter reading. To use on a suspected TV circuit, connect the input lead to the grid of the horizontal amplifier tube. Vary the set's horizontal hold controls. The meter reading should peak at some point of the adjustment. If it doesn't, either the horizontal oscillator is considerably off frequency or it isn't working at all. An off-frequency oscillator may result in complete loss of high voltage even though grid drive to the horizontal amplifier measures normal or even high.

This circuit will pick up enough signal to operate most vom's when it is connected to the grid of the horizontal amplifier, or, if the amplifier is working, from radiation when the pickup wire is placed near the plate circuit or flyback transformer. For added sensitivity and stability, use a ground wire to the TV chassis.

9. Checking local oscillators

The circuit in Fig. 12 is wonderful for checking transistor radios. It is not always easy to be sure that the oscillator is working, and much harder to tell whether it is working at the right frequency.

All that you need is this circuit in a small box. With an operating radio, calibrate three or four reference points on the capacitor dial. (A radio with a 455-kc i.f. has an oscillator frequency of 455 kc *plus* the station frequency to which it is tuned. If the radio is tuned to 600 kc, the oscillator should be at 1055 kc.)

The coil is a ferrite-core type adjustable antenna coil. The capacitor is variable from about 10 to 365 pf. It is better, but not absolutely necessary, if you remove a few turns from the antenna coil so that the tuning range will fall in the 800-kc to 2,000-kc vicinity. This will let you cover just about all the broadcast band for either 455- or 262-kc (most car radios) i.f. systems.

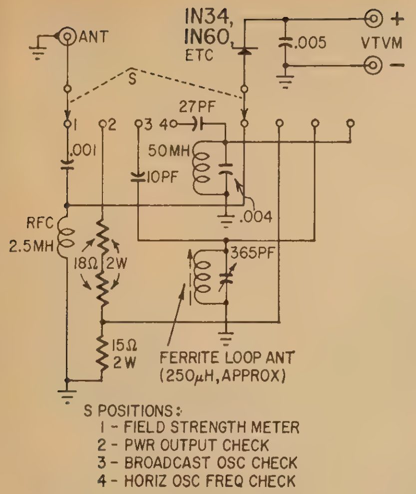


Fig. 13—Composite adapter combines functions of four circuits into one.

This circuit works well with higher frequencies. Just use an appropriate coil-and-capacitor combination.

10. Meter use-extender combination

Fig. 13 shows a circuit that may be built in a small metal box with appropriate connectors. It performs four of the previously discussed applications (1, 2, 8 and 9) and makes a versatile and important extra piece of test gear when used with your vom or vtvm.

The first position is a broad-band field-strength circuit. The rf choke may be salvaged from an old TV—a peaking coil from the video circuit. The .001-μf capacitor is not critical. Its purpose is to block an accidental application of dc.

The second position is the dummy antenna, power and modulation check for CB radios.

The third position is the wave-meter type detector for checking oscillators in broadcast radios.

The last position is for checking TV horizontal oscillator frequency.

Wiring is not extremely critical, but wires should be kept as short and direct as possible. All the components can be mounted directly to the switch contacts, jacks or ground for rigidity.

All these circuits have been tested and unless otherwise specified will work with a vtvm or a 20,000-ohm-per-volt vom and, in some cases, with a less sensitive vom. The basic meter movement of a 20,000-ohm-per-volt unit is 50 μa; in a 1,000-ohm-per-volt it is 1 ma, so it is obvious that the 1,000 has 20 times less sensitivity than the 20,000.

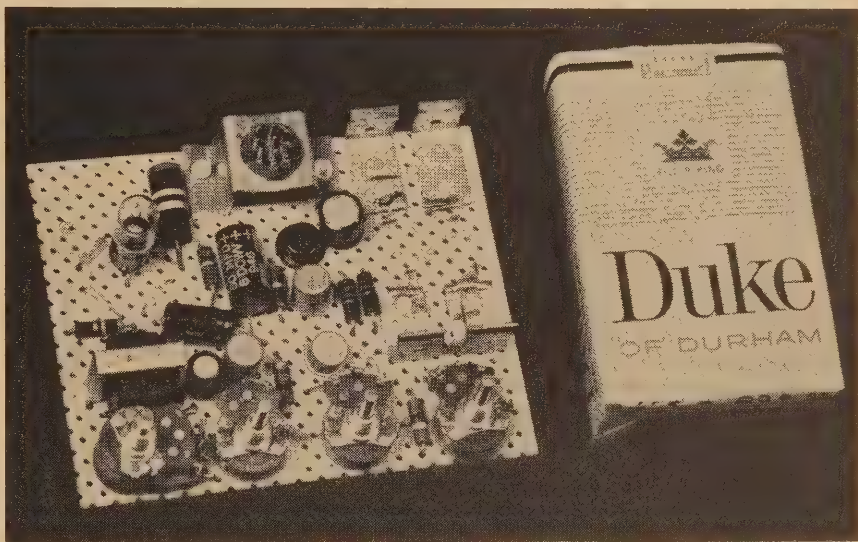
Today the 20,000-ohm-per-volt meter is no longer a luxury. Several fairly accurate ones sell for less than $30—some for less than $20. END

ELECTRONIC MUSCLE EXERCISER

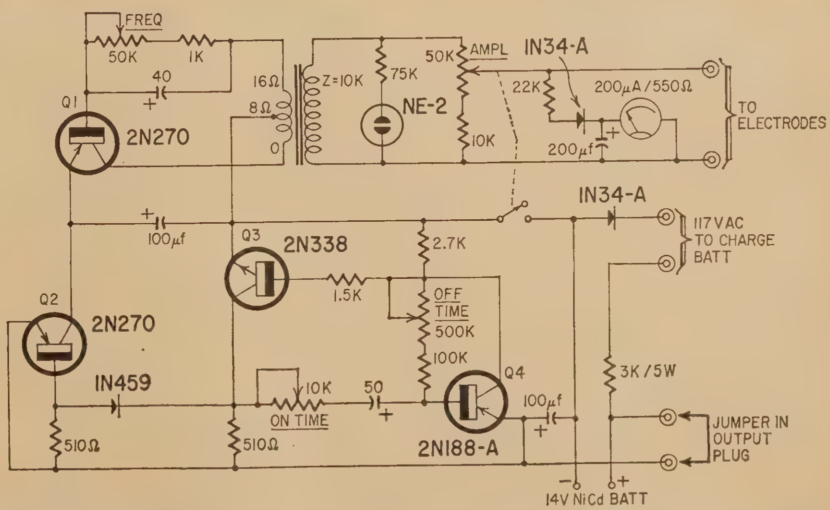
EARLY ELECTRICAL EXPERIMENTERS discovered that an electric shock applied to a section of the body causes muscles to contract in that area. Today, some doctors and physiotherapists prescribe controlled low-voltage electric impulses in treating certain muscular disorders, maintaining or restoring muscle tone and for exercising muscles in local areas. Many of the machines in use today are in large office type consoles.

Micro Precision Corp. of Brooklyn, N. Y., has devised a miniature portable electronic muscle exerciser that it expects to market within the near future. The unit uses transistors and measures 3 x 4 x 1 inch—about the size of two packs of cigarettes. The instrument (see schematic) uses a 14-volt NiCad battery and has a built-in trickle charger.

The output wave is a carrier whose frequency is variable from 20 to 4,000 cycles. It is modulated by pulses with both on and off times adjustable from 0.1 to 7 seconds. The output across 1,000 ohms—the average body resistance between the applicator electrodes—is 15 volts. END



Under-chassis view of the instrument.



Circuit of electronic muscle exerciser. Q1 is the carrier oscillator, Q2 is the modulator and Q3 and Q4 form multivibrator-type pulse generator.

Meters for Beginners

HOW DO THEY WORK?

By ROBERT G. MIDDLETON

THE MOST WIDELY USED ELECTRIC MEASuring instruments are voltmeters, milliammeters and ohmmeters. They measure the quantities stated in Ohm's law: I = E/R.

Most voltmeters are hooked up to measure either ac or dc voltages. Milliammeters for ac are less common, simply because voltage is measured much more often than current in practical work. On the other hand, resistance is measured almost as often as voltage. Hence, we would expect to find ac ohmmeters in wide use—and we do. Generally found in separate units called capacitor testers, they are calibrated not in ac ohms, but in microfarads.

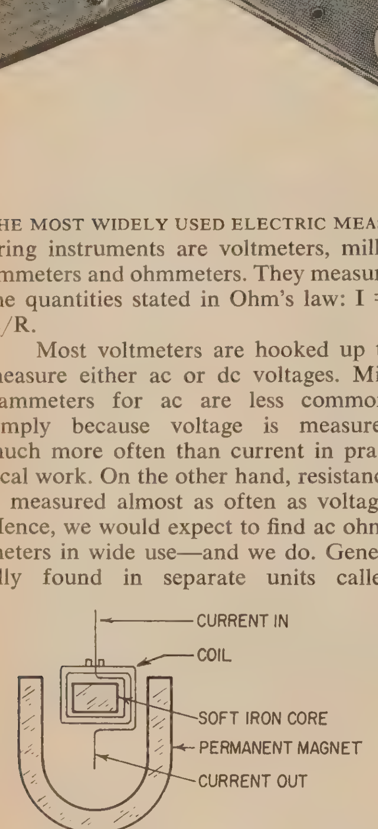


Fig. 1—Principle of d'Arsonval (moving-coil) meter movement.

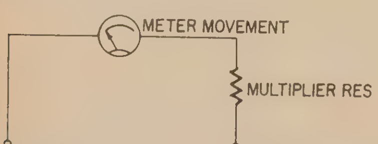


Fig. 2—Basic dc voltmeter circuit: movement in series with multiplier resistor.

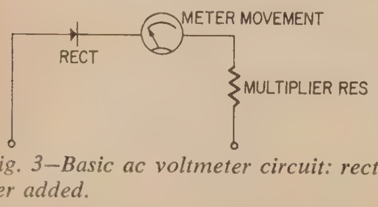


Fig. 3—Basic ac voltmeter circuit: rectifier added.

How basic meters work

The heart of a meter is its movement (Fig. 1). Basically a current-indicating device, it responds to dc only. To measure dc voltage, a multiplier resistor must be connected in series with the meter (Fig. 2). Now, if a rectifier is connected in series with the movement (Fig. 3), we get an ac voltmeter.

A vom has several current *ranges,* and the current-indicating circuit is elaborated as in Fig. 4. This is a milliammeter configuration with three ranges. It responds to dc only. A simple change of test-lead connections changes the configuration into a dc ammeter (Fig. 5). The ammeter function is *not* wired into the switch circuit, because the switch contacts are small and will not carry heavy currents satisfactorily.

A practical *dc voltmeter* must also have several ranges (Fig. 6). Note here that the voltmeter circuit has comparatively high input resistance, compared with the milliammeter circuit—this distinction is typical of nearly all voltage and current instruments. There are occasional exceptions. For example, in checking some of the low dc voltages in *transistor circuits,* a 0.25-volt full-scale voltage range can be useful. In such case, you can use the 50-μa range of a vom as a voltmeter, with full-scale deflection at 0.25 volt.

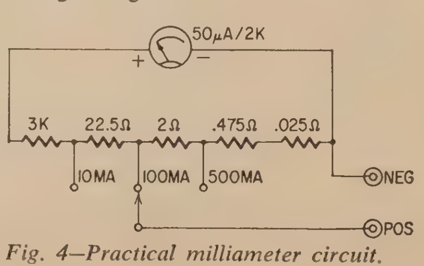


Fig. 4—Practical milliameter circuit.

An *ohmmeter* is obtained by switching an internal battery into the measuring circuit in (Fig. 7). Note how the circuitry is arranged basically to indicate the current that flows from the internal battery through the resistor under test. However, the scale used on this function is calibrated in ohms. This is a simple and convenient circuit arrangement, al-

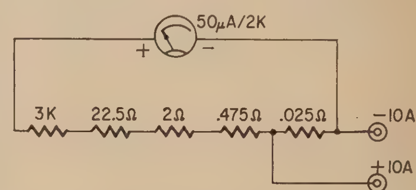


Fig. 5—Ammeter circuit is electrically same as Fig. 4, but separate terminals are brought out to avoid high current through range-switch contacts.

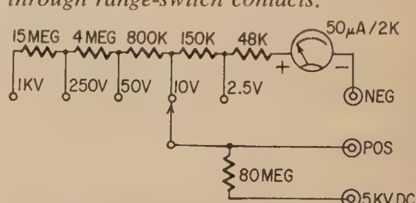


Fig. 6—Practical dc voltmeter circuit.

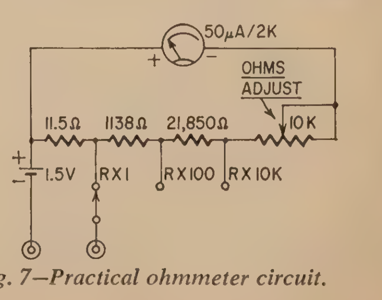


Fig. 7—Practical ohmmeter circuit.

Fig. 8—Ohmmeter circuit of Fig. 7 results in nonlinear scale.

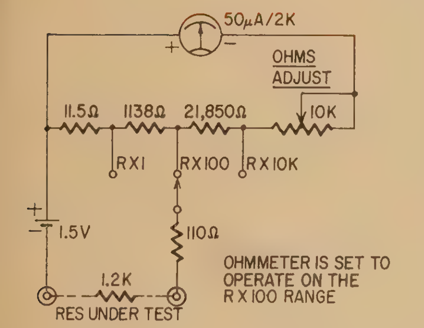


Fig. 9—Ohmmeter reads half-scale when resistance being measured equals internal meter-and-network resistance.

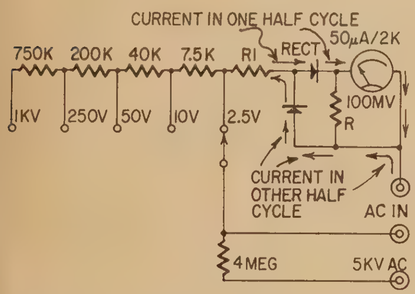


Fig. 10—Practical ac voltmeter circuit, with shunt and series rectifiers.

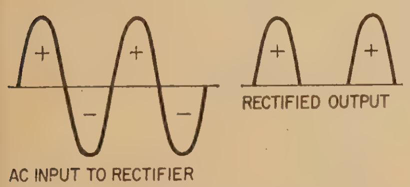


Fig. 11—In Fig. 10, half sine waves (alternate half cycles) flow through the meter movement.

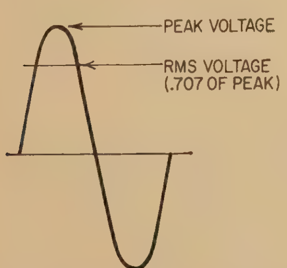


Fig. 12—The meaning of root-mean-square (effective) voltage.

though it results in a nonlinear ohms scale cramped at the high end (Fig. 8). When the resistor under test has the same value as the total input resistance of the ohmmeter, the pointer deflects to one-half of full scale (Fig. 9).

A practical *ac voltmeter* must also have several ranges. Hence, a multiplier is used, illustrated in Fig. 10. Two rectifiers are used in this circuit, although only one of them supplies current to the meter movement. The series rectifier supplies the rectified output in Fig. 11. Why, then, is the shunt rectifier used at all? It is because the series rectifier is not 100% perfect. It conducts *some* slight current in the reverse direction, although its back resistance is high.

To obtain the effect of a higher back resistance, the shunt rectifier is used. It provides a low-resistance shunt path *around* the meter to prevent any reverse current from flowing through the movement. Calibrating resistors R and R1 in Fig. 10 are set at the factory. The scale of the ac voltmeter reads in *rms volts*. An rms (root-mean-square) ac voltage is one that has the same *heating effect* as an identical value of dc voltage. The heater in a vacuum tube will get just as hot whether it is supplied with 6.3 volts dc or with 6.3 *rms* volts ac. It so happens that an rms voltage is 0.707 of the *peak* voltage in a *sine* wave (Fig. 12).

Because ac voltmeters like the one diagrammed in Fig. 10 are calibrated to read rms voltages of sine waves, these instruments will *not* read the rms voltage of a square wave or a sawtooth or any complex wave. Thus, this type of ac voltmeter must be restricted to measuring sine-wave voltages. This is no great handicap; other types of instruments (especially the oscilloscope) are available for measuring the voltages of complex waves found in TV receivers.

How about measuring *alternating current?* The simplest, if not the most convenient, method is to insert a precision resistor in series with the line, and to measure the alternating voltage across the resistor (Fig. 13). Then, the current can be calculated by Ohm's law. For example, if you measure 2 volts across the 5-ohm resistor, the current flow is evidently 0.4 ampere. A somewhat more professional method of measuring alternating current is to use a current transformer ahead of the voltmeter (Fig. 14).

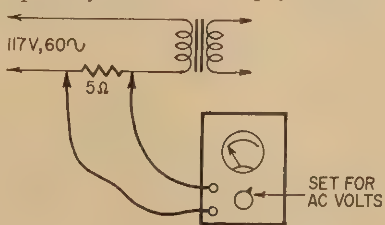


Fig. 13—One way of measuring alternating current: measure drop across series resistor.

Complete vom circuit

The complete circuit for a standard vom is shown in Fig. 15. The fuse in the common lead is a protective device. Since the ohmmeter has a low input resistance on the R × 1 range, the 11.5-ohm resistor could be burned out if the test leads were accidentally connected into a "live" circuit. The fuse will blow in such case, protecting the ohmmeter circuit.

Note also in Fig. 15 that the two instrument rectifiers are connected in a bridge circuit with two 5,000-ohm resistors. In this configuration, *full-wave* rectification takes place (Fig. 16). This does not change the ac voltage indication, because the meter scale is calibrated to read rms volts, as it is in the case of the half-wave configuration. It is interesting to observe the meter current in each case (Fig. 17). When a half-wave instrument rectifier is used in a vom, the movement responds to *0.318 of the rectified peak* voltage, and the scale is calibrated to indicate 0.707 of peak. On the other hand, when a full-

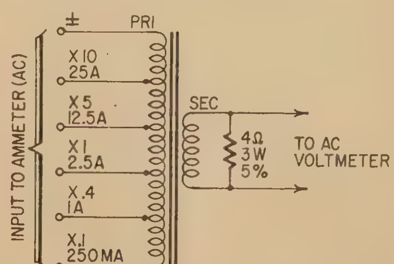


Fig. 14—Current transformer is another way of measuring alternating current.

wave instrument rectifier is used in a vom, the movement responds to *0.636 of the rectified peak*, and the scale is calibrated as before to indicate 0.707 of peak. Basically, therefore, *the full-wave* arrangement is *twice as sensitive* as the half-wave configuration.

Observe the shaded areas in Fig. 17. These emphasize the *equal areas* in the rectified current sine wave, which determine the *average value* of the rectified wave. This is 0.318 of peak for a half-rectified sine wave, and 0.636 of peak for a full-rectified sine wave.

Voltmeter sensitivity

All voltmeters have a rated *sensitivity* which is specified as *ohms per volt*. What does this mean? This rating refers to the input resistance of the voltmeter. To find the ohms-per-volt sensitivity of a vom, divide the full-scale indication on any range into the input resistance on that range. Thus, if your meter has an input resistance of 50,000 ohms on its 2.5-volt range, its sensitivity is 20,000 ohms per volt. This same meter will have an input resistance of 200,000 ohms on its 10-volt range. In other words, a vom has the same *sensitivity* on all ranges, but the input resistance is low on the low ranges, and high on the high ranges. A 20,000-ohms-per-volt meter has 100 megohms of input resistance on its 5,000-volt range.

It must not be supposed that a vom will have the same ohms-per-volt rating on its ac voltage range. Thus, a meter which has 20,000-ohms-per-volt sensitivity as a dc-meter, commonly has 1,000- or 5,000-ohms-per-volt sensitivity on its ac-voltage function. Meters with half-wave rectifiers may have an ac sensitivity of 1,000 ohms per volt, while meters with full-wave rectifiers generally have one of 5,000 ohms per volt. Why the difference? Because instrument rectifiers are contact rectifiers. To control the characteristics of contact rectifiers satisfactorily, lower-impedance circuits must be used than on the dc function. Hence, vom's using contact rectifiers will necessarily have lower input resistance on their ac-voltage function.

The sensitivity of a meter matters to the technician, because it tells him how much the meter will load a circuit, or, it indicates that circuits exceeding a certain impedance cannot be tested accurately. In practical work, we prefer to keep the input resistance of the vom at least 10 times higher than the impedance of the circuit under test. Thus, in measuring agc voltages with a vom, it is usually desirable to use as high a range as possible that will still provide a readable indication. In this way, the measurement error due to loading is minimized. END

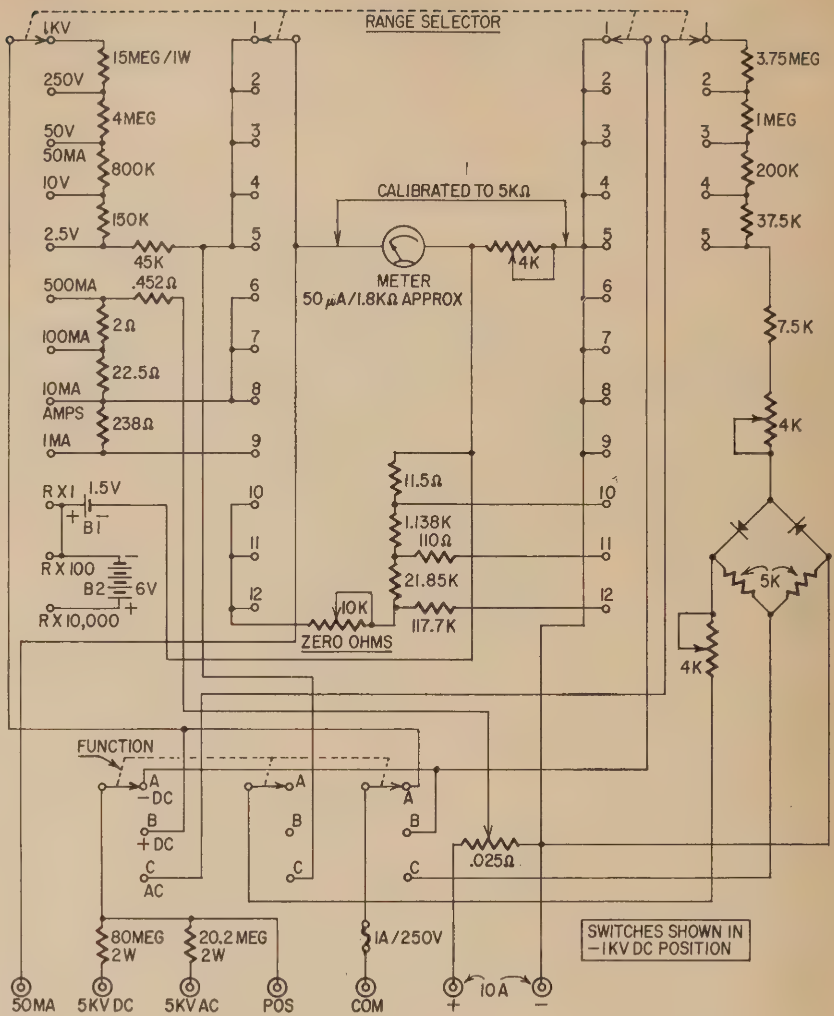
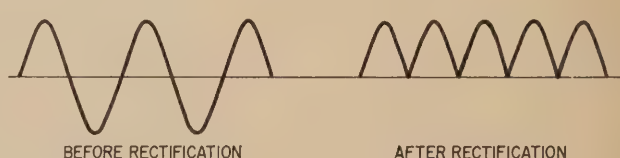


Fig. 15—Typical complete vom circuit.

Fig. 16—Full-wave rectified dc uses both halves of ac cycle.



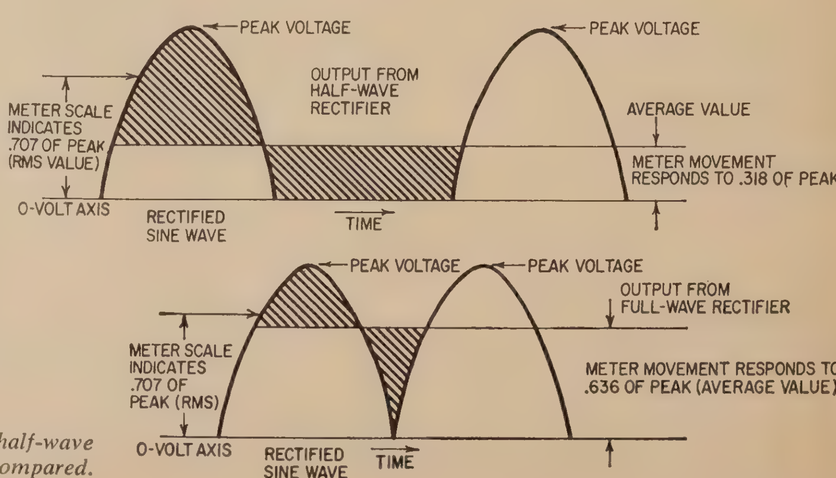


Fig. 17—Full-wave and half-wave rectified sine waves compared.

SYNC CLIPPERS: HOW AND WHY

Another installment in Radio-Electronics' basic TV series. How sync clippers work, what they do, and how to handle their troubles

By JACK DARR
SERVICE EDITOR

SYNC CIRCUITS ARE IMPORTANT: CUStomers will complain about rolling, jumping pictures long before anything else. Some sync clipper circuits can look pretty wild, but they're all based on a very simple vacuum-tube action.

In a TV signal, the top 25% is sync; the rest, video. We have to chop off the top quarter. To do that we use the grid-voltage–plate-current curve of a tube. If we feed a signal into a tube biased in class A, we get it all back (Fig. 1-a). In class B, we can take out only a part of it (Fig. 1-b). So, we can feed in a video signal, bias the tube right and "clip off" only sync (Fig. 2).

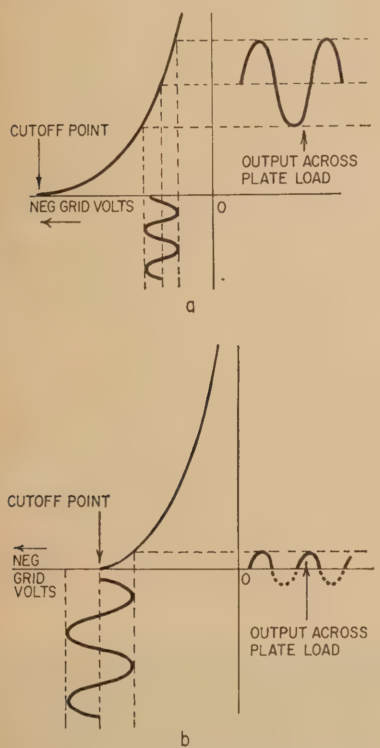


Fig. 1-a—In class-A amplifier, bias and signal voltages are adjusted so that signal is amplified (theoretically) without distortion. Fig. 1-b shows what happens when signal swings negative and positive around bias near cutoff: only positive peaks of signal appear. Everything else is clipped off and left behind.

That's where we get the name "sync clipper." We take this pair of electronic scissors and trim off only what we want—the sync, without any video. Why? If we let video get into the sync circuits, we get jitter, because the sync must always be at a constant amplitude. Video is always changing, and we don't want that.

I like "sync clipper"; you'll find "sync separator" on some diagrams. The circuit actually "clips"; the sync isn't separated in the tube, but in the plate circuit. How? Let's see.

In modern US TV design practice, vertical sync works on *amplitude* and horizontal sync on *phase*. Vertical sync pulses actually "fire" the vertical oscillator directly. This action depends on their voltage (amplitude). Horizontal sync depends on phase more than on voltage. The sync and a comparison pulse from the oscillator are fed to a phase-comparer circuit; the dc output from that controls the oscillator, and not the sync itself.

How do we separate these two parts? Feed the composite sync, with 60-cycle vertical pulses and 15,750-cycle horizontal pulses, into a two-branch circuit in the plate load of the tube, as in Fig. 3. How can this "separate" 'em? Look at the capacitors. The reactance of a capacitor varies inversely with the frequency. So, we use very small capacitors in series with the horizontal sync. In Fig. 3, the 100-pf coupling capacitor has 100,000 ohms reactance at 15,750 cycles, but 26.5 megohms at 60 cycles. It's going to pass a lot more horizontal sync than vertical.

In the vertical circuits, you'll find big capacitors *in series* (low loss to 60 cycles) and almost as big ones used as *bypasses* (low-impedance paths to ground for 15,750 cycles) plus big series resistors. So, the high-frequency horizontal sync goes off to ground and the low-frequency vertical sync goes on through. The R-C network shown is a "vertical integrator". It has a very low reactance to ground for high-frequency signals, and a high series resistance, from the big resistors. It also combines the equalizing pulses into nice clean vertical sync pulses.

Sync clipper action depends on *bias*. You'll find several circuits used to make sure that this stage gets the right bias all the time. Notice that in the circuit of Fig. 3 the grid resistor goes to B-plus. Fig. 4 shows the voltages found in an actual circuit. What?—12 volts negative on the control grid? How can this be, when the grid is connected back to 125 volts? Look at the size of that resistor—15 megohms! This tube is very heavily driven; note the 65-volt peak-to-peak video signal on the grid. So we regulate the amount of negative bias it can develop by returning the grid resistor to B-plus. This positive voltage helps to hold the grid voltage constant.

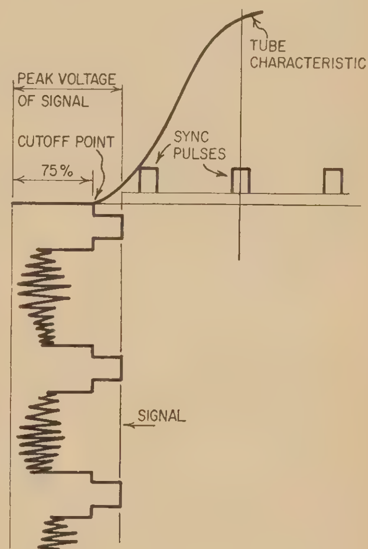


Fig. 2—How idea of Fig. 1 works with video and sync. Video signals simply drive tube further into cutoff, and don't appear in output. Sync pulses alone drive tube into conduction and are amplified.

Watch out for the big resistors in this circuit. They're always more critical than we think. Although we might think, "Oh, well, 15 megs, what the heck! If it does go off a little, it's so big it won't make much difference!" The heck it won't! Look where it is: in the *grid* circuit! It takes only a few volts here to make a *lot* of difference. These big rascals *are* critical. If you have troubles, check each of them to be sure that they're still within tolerance. They can upset the bias and cause troubles.

Servicing

Now let's see how to check these circuits, find faults, and repair 'em. Might just as well turn the scope on

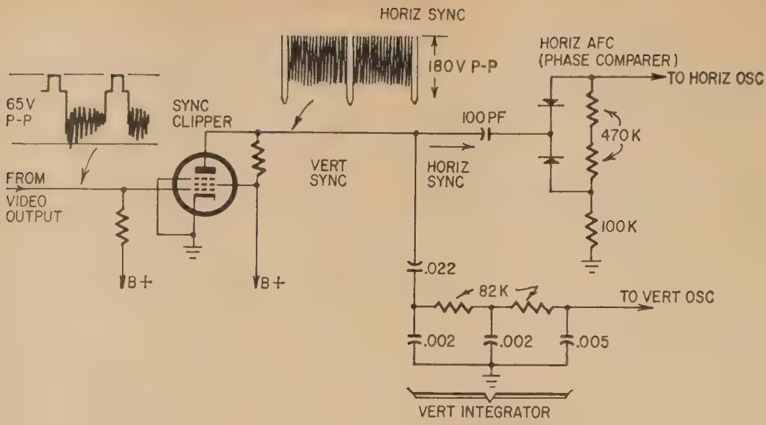


Fig. 3—Sync separation depends on the fact that vertical sync pulses occur 60 times a second, while horizontal ones come along 15,750 times a second. Small capacitor lets horizontal pulses through, rejects vertical. Vertical pulses pass through vertical integrator, which shunts away horizonal pulses.

right now, because we want to know things that only the scope can tell us.

If you have sync trouble, the first thing to do is sit back, take a good look at it and analyze the symptoms. *Which* sync is out, horizontal or vertical? Or both? This tells us where to start looking. No matter how *many* sync clippers are used, they'll fit the general scheme of Fig. 5.

Be logical: if *both* syncs are out, check circuits that handle the composite sync. If either one is out and the other OK, then check only the parts that carry the bad one. For example: if in Fig. 3 you had no vertical sync, you would check the vertical sync circuit going to the integrator and oscillator, not the horizontal afc circuit!

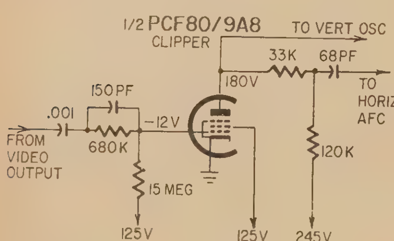


Fig. 4—Voltages found in actual sync clipper circuit. Note negative grid bias, despite connection to B-plus.

Do the "standard" service procedure first: replace the tube(s) and check all voltages. You'll fix most of 'em this way. Don't look for horribly complicated troubles till you get all the *simple* ones fixed!

After that, get the scope, with a low-capacitance probe (these circuits are all very-high-impedance) and start looking. Check the input first, of course. You should find the video signal on the input grid, looking like Fig. 6. It may not be exactly like that, nor like the

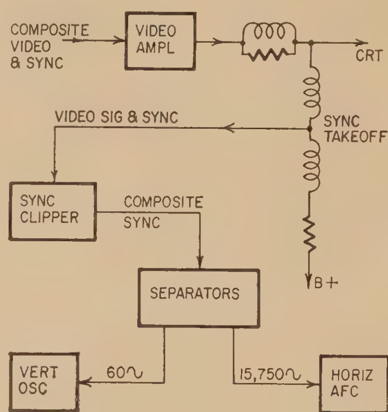
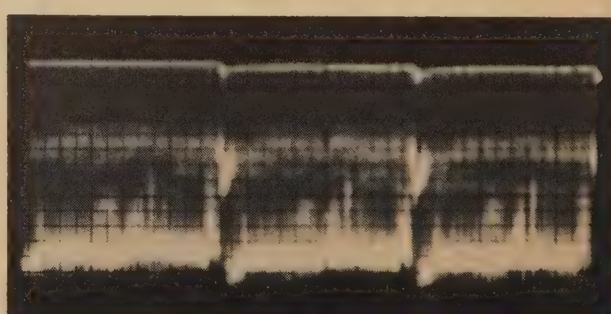


Fig. 5—Block diagram applies to just about all sync clipper-separator circuits. Details vary from model to model.

ideal video signal with 25% sync and 75% video. It comes from a tap on the video amplifier plate load, and may go through some kind of a filter network on the way. However, if it's OK, there'll be plenty of *sync* there. At this point, watch out for sync compression! Your sync trouble may be caused by sync clipping in the video i.f., video amplifier, etc. Check agc setting, and so on, *before* you tear up the sync circuits! The scope'll show you if there is any trouble.

Fig. 6—Composite video signal at sync clipper grid. Slight compression of whites at bottom is OK in this case, but watch for compression of sync pulses, top.



If this signal is OK, look in the plate circuit. You'll find the composite sync looking like Fig 7. The blur in the middle is horizontal sync pulses, and the bright vertical streaks are vertical sync. This is with a 30-cycle sweep. Check the amplitude against the value shown on the schematic. Note that we're getting not only clipping but amplification out of this tube. Some circuits have no amplification, but merely clip; check the peak-to-peak voltages given on the schematic, to be sure.

If you have vertical troubles, follow the vertical sync, from the plate, down through the integrator to the sync input of the vertical oscillator. You'll have to kill the oscillator, by pulling the tube or unhooking the B-plus, otherwise the large pulses from the oscillator will mask the sync completely. The vertical sync at the oscillator input should look like Fig. 8 and should be within 10% of the amplitude shown on the schematic.

Horizontal sync can be checked in the same way, but you don't have to kill the oscillator, since the sync pulses themselves never get any farther than the afc circuits. Check for the presence and amplitude of the comparison pulses while you're there.

Troubles in sync circuits

Trouble in sync circuits is caused by weak tubes, leaky paper, ceramic *or mica* capacitors. Don't overlook the little mica coupling capacitors used to feed sync pulses into circuits! They can go bad just like any others! (A lot of us old-timers have a regrettable tendency to think they can't, but they sure can!) Also, check for resistors that have drifted off value. Watch out for big resistors: 3, 5 or even 15 megohms are often used in voltage-divider circuits, and are they ever critical! Because of the numerous parallel paths in such circuits, *always* lift one end of a resistor before measuring it.

Don't change values of resistors to "make it work". If it won't work with the original part-values, something else is wrong. Probably a capacitor with a very small leakage. In circuits like this, even a 5-megohm leakage in a capacitor can play hob with things like cutoff bias.

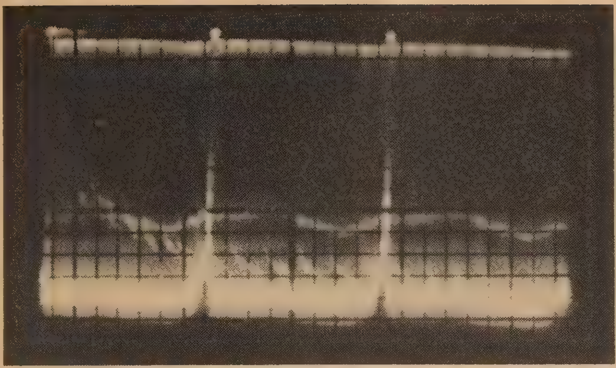


Fig. 7—Composite waveform at sync clipper plate. Small sharp spikes are vertical pulses; blur between them, horizontal pulses. A little video is left (white bar along bottom). That much is all right.

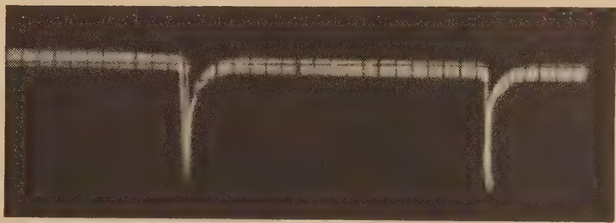


Fig. 8—Model vertical sync pulses. Vertical oscillator was killed by removing tube. Check amplitude of these against waveforms in service data.

You'll find different versions of these circuits. One is shown in Fig. 9. The vertical sync is taken off at the cathode and horizontal from the plate. Incidentally, although we showed pentodes before, this is a triode. Makes no difference in the basic action; pentodes are often used because they give gain, as well as clip sync.

Another form you'll find is the "noise-immune" sync clipper (Fig. 10). This uses a tube like a 6BE6, etc., with two control grids. Grid 3 does most of the work; it has a large video signal, taken from the video output, and works exactly like the circuits previously described. Grid No. 1 (nearest the cathode) has a very small video signal from the video detector, opposite in phase to that on grid 3.

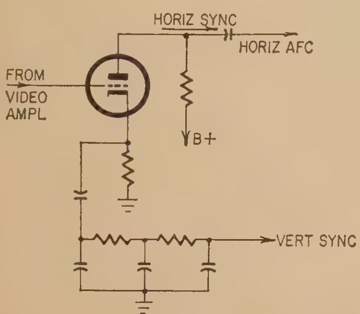


Fig. 9—In some circuits, horizontal sync comes from plate of tube, vertical from cathode.

Forget grid 1 for now. The rest of the tube works exactly like any other sync clipper. The bias on grid 1 is set so that the *normal* video signal there has no effect on the electron stream in the tube. If a noise pulse comes along, it will drive grid 1 negative (toward cutoff), and cut off the electron stream. Because this grid is so near the cathode, only a small voltage on it will have a great effect. Now the noise pulse has cut its own throat: because the tube is cut off, the noise pulse can't get through to the

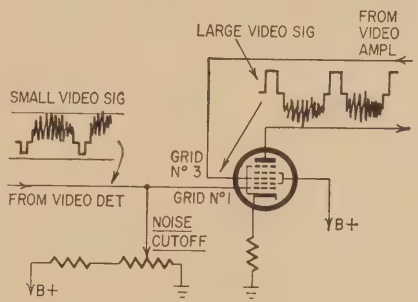


Fig. 10—Noise-immune sync clipper. Text explains how this circuit works.

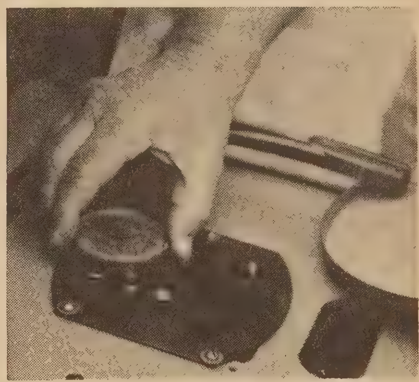
plate circuit. Because of their "flywheel" action, the two oscillators keep on running without sync until the noise pulse has left and the sync clipper conducts again.

The level at which this action starts is controlled by a variable bias. This is known as Range Finder, Fringe-Lock, and by other names. It sets the bias so that in ordinary circumstances, grid 1's signal is *just below* the level at which it will have any effect on the tube's plate current. Watch out for this control: if someone has turned it, it will clip off not only the noise, but the sync as well! Be sure that this isn't happening before you go into the rest of the circuits. Symptoms: loss of both syncs, and, usually, a slightly torn-up picture. Best thing, while servicing, is to set this control all the way "out", so that *this* circuit can't have any effect. Then, when you finish, readjust it.

So there you are. Using a scope with a low-capacitance probe, a voltmeter and your noodle, you can chase out sync troubles in a jiffy. You can follow sync spikes through a circuit just as easily as a video or rf signal! END

Save Turntables from Too-Early Junking

THOUSANDS OF TURNTABLES AND PHONOMOTORS are junked annually because of some minor defect or malfunction. Many of these can be easily renovated and made into serviceable record players. While they may not provide hi-fi reproduction, they will give their users much pleasure.



These are frequent turntable troubles:

1. Turntable slippage. To cure this, masking tape is sometimes applied to the inside rim. This changes the speed and is unsuitable if you are a music lover. If the slippage is the result of worn idler or drive surface (this can be easily determined by inspection), a coat of rubber cement or an application of powder resin might be the simple cure. However this will rarely end the slippage because it often results from a weakened pressure spring. Increase the spring tension and the trouble will disappear.

2. Noisy operation. Often the fault of a dry turntable or idler shaft. The remedy is obvious. Rough spots on the inner surface of the rim can cause a clicking sound. Another rather frequent cause of noise is metal-to-metal contact when the motor is set in motion. I discovered an example of this recently when I noticed that the speed-change arm was contacting the head of a motor mount screw. A bit of insulating material ended the trouble and prevented a quality unit from being discarded. Flat spots on the rubber driving disc can cause noisy operation. In some cases the rubber surface can be smoothed out with sandpaper.

3. Motor inoperative. When a turntable motor won't run, don't overlook the obvious: loose contacts in the plug or at the motor terminals. A turntable motor rarely burns out. When it fails, a poor connection is almost invariably the cause of the trouble.—*Glen F. Stillwell*

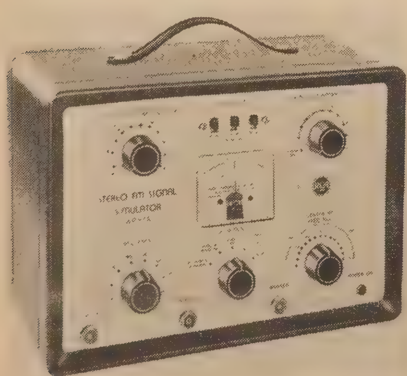
A Roundup of Low-Cost FM Stereo Generators

Servicing multiplex tuners and receivers need no longer be a pastime of the idle rich! It's getting so you can hardly afford not to have one!

By LEONARD FELDMAN

UNTIL VERY RECENTLY, THE TECHNICIAN confronted with defective FM stereo receivers or tuners had to face two unpleasant alternatives. He could either attempt to repair the equipment by using a station signal or he could purchase one of the many fine FM-stereo signal generators—at $300 to $1,000.

Fortunately, at least four new pieces of equipment have been introduced in the last few months. Any one of them will enable you to test and repair FM stereo equipment. All these new models are priced from $100 (for the Heathkit model IG-112 in kit form) to around $250. Considering that most of them can also double as an FM rf generator, it may be well to weigh the advantages of approaching FM stereo troubles with professional test equipment.



RCA WR-51A Stereo FM Signal Simulator

This compact instrument generates all the signals for complete service and maintenance of multiplex adapters or mono and stereo FM receivers:

1. Composite stereo output signal for either left or right channel, and a special "phase test" signal (L + R in phase) for accurate phase adjustment of subcarrier transformers. These signals can be modulated internally with 400-, 1,000- or 5,000-cycle frequencies.

2. A variable-level, crystal-controlled 19-kc subcarrier signal for checking "lock-in".

3. Four additional sine-wave signals, 28, 38, 48 and 67 kc, for adjusting the bandpass networks in stereo receivers.

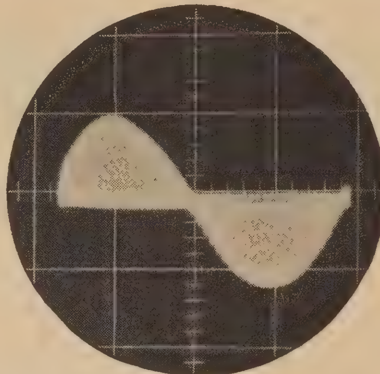


Fig. 1—Composite stereo signal consisting of left-only 1-kc tone and 19-kc pilot. (From RCA WR-51A.)

4. A 100-mc carrier, adjustable ± 0.8 mc to a quiet point in the FM band. This may be frequency-modulated with the composite stereo or monophonic information, with deviation adjustable from 0 to 75 kc.

5. 100-mc sweep, with range adjustable from 0 to 750 kc at a 60-cycle rate, permitting overall rf/i.f. alignment checks.

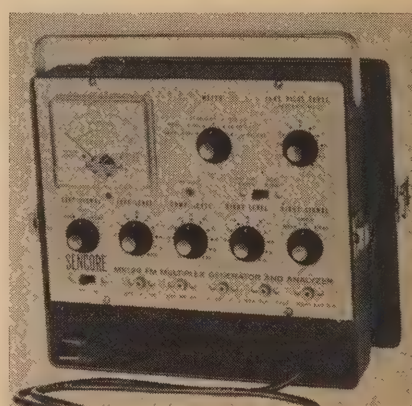
6. Crystal-controlled 5.35-mc signal to provide a 10.7-mc intermediate-frequency marker, and harmonic markers at 90.95, 96.3, 101.65 and 107 mc for rf alignment of a complete FM stereo tuner or receiver.

The rf output (which measures about 0.1 volt) can be attenuated in three steps of 20 db each, for a total of 60 db. At full attenuation, therefore, the output is about 100 μv, low enough to check over-all FM circuitry under semi-fringe conditions. Loose-coupling the rf cable to the receiver under test will attenuate the signal further. I used this equipment for more than a month and found it reliable and extremely versatile. Fig. 1 is a scope photo of the audio composite signal available at the "composite signal" (COMP SIG/AUDIO) output when a "left only" or "right only" signal of 1,000 cycles is selected. Fig. 2 shows a composite output when 5,000 cycles is the modulating "left only" or "right only" signal. At this higher frequency, I was able to sync the scope to discern clearly the outline of 5 kc as well as the "suppressed subcarrier" frequency of 38 kc. The 19-kc pilot signal, clearly superimposed on the waveform of Fig. 1, was deliberately turned off in Fig. 2 for clarity.

The WR-51A also has a zero-center meter for checking balance. You will still need an ac vtvm for setting up proper levels.

With this equipment, as well as the Heath IG-112, *either* left *or* right signal *only* can be selected. It is not possible to feed one frequency to the left channel while another is fed to the right. Also, since there are no terminals for external modulation, separation can be checked only up to 5,000 cycles. It is true that if separation is still good at 5,000 cycles, it is *likely* to be good at 15,000 cycles. But it would be nice to be able to check.

Separation in the composite signal is better than 30 db—as good as or better than the maximum separation capability you're likely to encounter in any commercial FM stereo receiving equipment.



Sencore MX129 FM Multiplex Generator & Analyzer

Forgetting for a moment that this unit is all-transistor (and hence the most compact stereo generator I have seen), the novelty in its design approach merits detailed discussion.

The MX129 is extremely rugged and lightweight, making it ideal for "on the scene" analysis and troubleshooting. But its portability is limited to weight only, for it—like the other units—requires a 117-volt line despite its solid-state circuitry. Signals at the various output jacks include:

1. FM rf carrier with composite multiplex audio signal, much like that described earlier.

2. Multiplex audio frequencies formed either by 60 cycles (derived from a 6.3-volt winding on the power transformer) or by 1,000 cycles from a built-in audio generator.

3. Full control over left- and right-channel amplitude. This is the design departure that makes this unit so different. Instead of having a "mono" switch position, a monophonic signal is created by applying equal left and right signals of the same frequency. Whenever L = R you have, in effect, a monophonic signal by definition. Carrying this design philosophy further, Sencore makes available two external inputs into which can be fed any modulating frequencies. Thus, you can apply (from a separate audio generator) 10,000 cycles to one channel and 1,000 cycles to the other, and check channel separation by listening (or watching a scope) for what "sneaks" through.

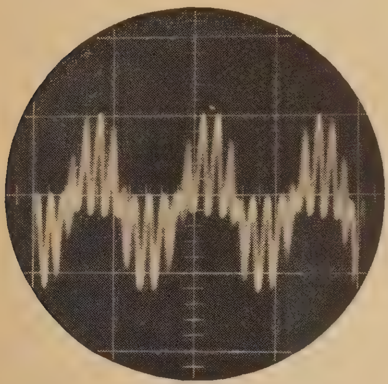


Fig. 2—Composite stereo signal with 5-kc left-only modulation. The 19-kc pilot has been killed; rapid fluctuations you see are 38-kc switching waves (or subcarrier sidebands, if you like to look at it that way).

Because of the external modulation provisions, you could even simulate an actual stereo musical program with records or tapes. Even without external signal sources, the built-in 60-cycle signal can be fed to one channel while the built-in 1-kc tone is fed to the other.

4. A 19-kc pilot, calibrated directly in modulation percentage, can be used without audio modulation by simply turning down left and right audio controls completely.

5. An external 67-kc signal for SCA (subscriber background music) trap adjustment.

A built-in meter circuit is used to set controls of left and right channels as well as the level of the composite signal. Wisely, since the meter is there anyway, its circuits are made available externally so that it can be used as an ac meter with 3- and 30-volt peak-to-peak ranges.

The rf cable provides a signal at about 100 mc. This can be shifted with a screwdriver adjustment from the front panel to avoid interfering with a station.

Unlike the other two units discussed, there is no means for attenuating rf strength (except by loose coupling), so it is not easy to judge receiver performance at low signal strengths. In fact, no mention is made of the rf amplitude. I judged it fairly high, probably in the order of 3,000–5,000 μv.

With this instrument, you must use a scope to monitor the composite signal, at least until you become familiar with the controls and know exactly where to set them. For example, Fig. 3 is a photograph of the composite signal that would be obtained if the operator desired a left-channel signal only but failed to turn the RIGHT LEVEL control down completely. With such a signal fed to the FM receiver or multiplex adapter, you might waste a good deal of time wondering why you're not getting the 20- or 30-db channel separation you expected. Still, the flexibility of being able to control left and right separately is useful.

FM STEREO GENERATORS

FEATURES	RCA WR-51A	SENCORE MX129	HEATH IG-112	HICKOK 727
Circuitry	tubes	transistors	tubes	transistors
FM frequency	100 mc ±800 kc	100 mc +5, −10	100 mc ±2	100 mc ±250 kc
Rf sweep	yes	no	yes	no
Xtal markers	yes	no	yes	no
Rf atten.	60 db (20-db steps)	none	60 db (20-db steps)	none
Int. audio	400 cycles, 1 kc, 5 kc, 19 kc, 28 kc, 38 kc, 48 kc, 67 kc	60 cycles, 1 kc, 19 kc, 67 kc	400 cycles, 1 kc, 5 kc, 19 kc, 38 kc, 65 kc, 67 kc	1 kc, 19 kc, 38 kc, 67 kc
Ext. modulation	no	yes	no	no
L & R signals	L or R	both simult.	L or R	L, R, or sidebands
19-kc amplitude	adjustable	adjustable	adjustable	adj. 3 steps
Crystal-controlled 19 kc	yes	yes	yes	yes
Mono FM	yes	yes (make L = R)	yes	yes
Recommended aux. equip.	scope, ac vtvm	scope	scope, ac vtvm	scope, ac vtvm
Meter	yes, for channel balance only	yes	no	no

Heath IG-112 FM Stereo Generator

As usual, the Heathkit version of a stereo generator is a masterpiece of design, intended particularly for the technician or hobbyist who doesn't mind spending a few hours with pliers and soldering iron. When built according to instructions, this piece of equipment provides just about everything needed for FM stereo work. The design follows the RCA approach.

Signals generated by the IG-112 include an audio or composite stereo signal for multiplex adapter adjustments, or an rf carrier modulated by these same signals for overall receiver alignment and checking. A sweep function is also provided for overall rf–i.f. alignment with marker frequencies at 10.7, 90.95, 96.30, 101.65 and 107 mc. You can select either right- or left-channel signals as well as a PHASE TEST position for accurate adjustment of stereo subcarrier tuned circuits.

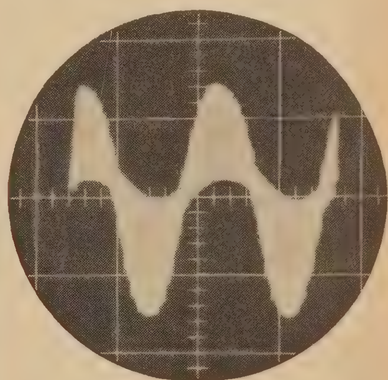


Fig. 3—Improper composite resulting from some left-channel signal in right channel, or vice versa. This is poor separation; can be the fault of multiplex section or of poorly aligned i.f. or detector in tuner.

Switch-selected audio frequencies include 400 cycles, 1 kc, 5 kc, 19 kc, 38 kc and SCA frequencies of either 65 or 67 kc. Note that 28 and 48 kc, deemed necessary by RCA, are not present in this equipment and are considered by Heath to be of minor importance. The 19-kc pilot signal is shown in Fig. 4.

The rf signal is 100 mc, plus or minus about 2 mc, and it can be attenuated in 20-db steps for a total of 60 db.

Since the Heath unit is so similar to the factory-assembled RCA generator, I thought I would investigate its kit-building aspects once I established that performance and waveforms were excellent.

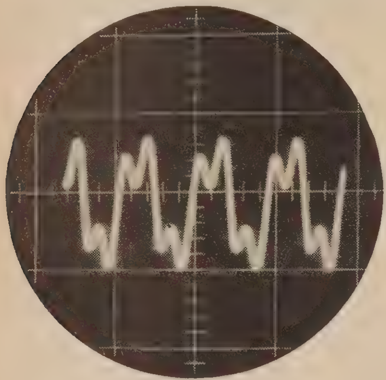
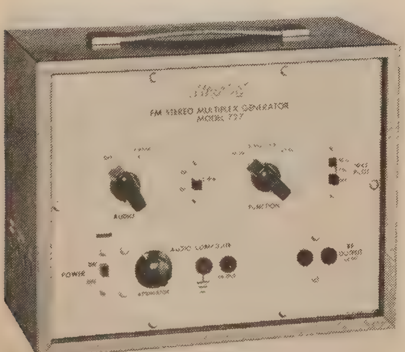


Fig. 4—The 19-kc pilot from Heath generator contains considerable second harmonic (38 kc). That doesn't affect anything.

As usual, a clean, open circuit layout provides easy access to all components for greatly simplified assembly. While I didn't actually assemble this particular unit, I did remove it from its case to examine the work involved. About two evenings of spare time would be my estimate for the time required to assemble the kit from a cold start.

All the units described provide all necessary cables. Heath was even thoughtful enough to send along a piece of 300-ohm lead terminated in the popular "clothespin" clip which attaches so easily to the antenna terminal screws of commercially built receivers.



Hickok model 727 FM-Stereo Multiplex Generator

The Hickok model 727 is all-transistor and quite light and compact, measuring only 11 x 8½ x 5 inches. It weighs only 6 pounds. It is the first unit I have seen that is battery-operated (22½-volt battery, not included with the instrument). While this feature might at first seem inconsequential, it does have its advantages when servicing in the field. Often all ac receptacles in the vicinity of the hi-fi rig are occupied by tuners, amplifiers, turntables, etc. The instruction manual indicates that a separate ac power supply is available for use in the shop, to prolong battery life.

The following signals are available at the output jacks of the model 727:

1. An FM-rf carrier modulated with the composite audio signal, whose frequency is a nominal 100 mc at a signal strength of approximately 500 μv.

2. Composite signal (audio) with a choice of L only (1 kc), R only (1 kc), mono (1 kc), separate 19-kc-only input, separate 38-kc signal and a SCA (67 kc) signal for aligning SCA rejection traps. This is the first of this group of generators I have seen that enables the user to examine subcarrier sidebands only (L $-$ R). This is possible because the basic circuitry of the instrument adheres to the original concept of producing a stereo signal:

Produce an L + R signal and an L $-$ R signal to amplitude-modulate the 38-kc subcarrier and then suppress the subcarrier itself, leaving only L $-$ R sideband information. Thus, by turning off the L + R slide switch on the instrument, it is possible to work with the L $-$ R component alone. This is particularly helpful when you work with some earlier multiplex adapters which followed the same circuit philosophy, for the L $-$ R circuits of the adapter can be aligned separately and independently of the rest of the circuitry.

3. The 19-kc signal is adjustable in switching steps of 0%, 5% and 10% of composite signal. The 5% position is useful for insuring correct lock-in of any 19- or 38-kc oscillators in the receiver under less-than-optimum signal strength.

Hickok's model 727, though it lacks some of the features of the other units tested (such as multiple audio frequencies, attentuation facilities and external modulation provisions), is adequately designed for use in the field and on the bench for servicing adapters and overall FM stereo receivers. It cannot take the place of an rf generator for FM alignment, because it has no 10.7-mc output and only one FM-band rf signal. But since nearly all shops already have an rf signal generator, this won't be too bad.

Already more than 300 stations across the country are transmitting FM stereo all or part of the time. More will be coming on the air each month. With stations airing so much stereo, sales of stereo FM receivers and adapters are mushrooming and this means more service business for the technician who has the proper know-how *and* the proper equipment. END

Longer Life For Ceramic Transmitting Tubes

SOME ENGINEERS HAVE HAD TROUBLE from short-lived 4CX250-B, 4X250-B or 4X150-A final amplifier tubes. Microscopic examinations of some of the defunct tubes have shown that their lives had been limited by high filament voltage.

Variations of line voltage from normal maintained for a long time cause excessive cathode heating. If a normal 6.0-volt filament is operated 0.5 volt above its rated voltage, the cathode temperature is increased by 25° C. This results in twice the normal barium loss and effectively reduces the cathode life by one-half.

When an indirectly heated cathode is heated above its normal operating temperature (approximately 825° C), the oxide material is deposited on cooler surfaces surrounding the cathode. If this keeps up, enough barium will be evaporated to cause loss of emission, high primary control-grid and screen-grid emission with heater leakage.

This problem shows up as frequent unexplainable high-voltage fuse failures. They are caused by initial arcing to the stringers of barium built up on the cathode, which then clear themselves. Regulated filament supply is recommended for these transmitting tubes. The panel voltmeter monitoring the filament voltage should be calibrated accurately against a 1% laboratory instrument of known accuracy.

The filament voltage limits on this family of tubes are 6.0 volts ± 5%, or a maximum range of 5.7 to 6.3 volts. For longest tube life, the filament voltage should never exceed 6.0.—*E. H. Marriner, W6BLZ*

"Well, you just grab the old blown out tube like this . . ."

Use the Right Equipment —and Save Time

"Remember that time is money."

—Benjamin Franklin, 1748

By G. M. ROBERTS

Test equipment is a status symbol, a merchandiser and a time-saving tool. Your test equipment is also a money-making machine. What does it do for you as a status symbol? It encourages a professional attitude, which promotes personal efficiency. Don't minimize motivation. If you have better test equipment than your competitor, the laws of human nature will drive you to live up to your own self-image. You simply can't escape the urge to "show up" the screwdriver mechanic who is groping in the dark.

How is test equipment a merchandiser? When customers walk into your shop, they are impressed by an array of businesslike (and to them mysterious) test instruments. You immediately command respect. When you call at a customer's home, he won't argue if "the machine shows that the big tube is bad." If you have to pull the chassis and give a comparatively high estimate, a few preliminary voltage measurements will reduce sales resistance.

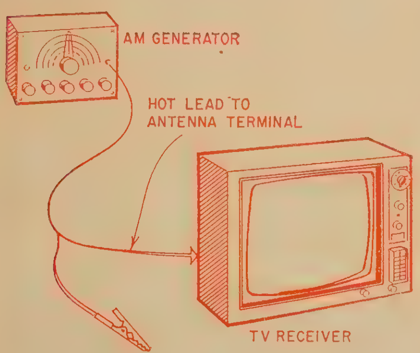


Fig. 1—Check for a dead local oscillator.

At the bench, test equipment is a time-saving tool. Troubleshooting has not been automated, and probably never will be. On the other hand, instrument analysis is an important approach to automation which you should exploit to the greatest possible extent. Don't overlook the capabilities of even the most basic test instruments. You might be wondering whether a vertical oscillator is supplying an output. Your vom will give you the answer. Set it to the "output" function. If you get a 75-volt reading, the trouble is not in the oscillator.

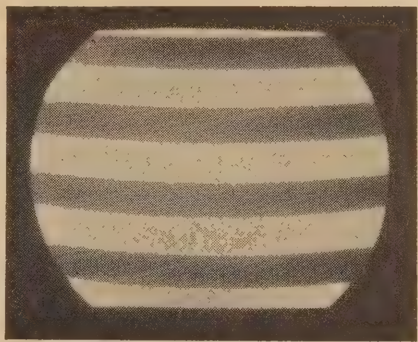


Fig. 2—AM signal generator makes this kind of pattern on TV screen.

Of course, this 75-volt reading will not jibe with the waveform voltage specified in the receiver service data. For example, a 75-volt reading is typical for a waveform specified at 150 peak-to-peak volts. However, you can determine *whether the waveform is there, or not.*

There are two reasons for the low reading of a vom in this type of test. First, the blocking capacitor in the vom circuit on its "output" function, is typically a 0.1-μf capacitor, which drops 60-cycle voltage appreciably. Second, the input resistance of a vom is comparatively low, which results in circuit loading. If your vom has a half-wave rectifier instead of a full-wave rectifier, the reading will be still lower because half the waveform will be rejected by the meter circuitry. The rejected half-cycle might have a much higher peak voltage than the accepted one.

Also, a vom is calibrated to read rms voltages of *sine* waves. It will read high on a square wave but low on a pulse because of the differing form factors. *Hence, the vom is useful chiefly to check for the presence or absence of complex waveform voltages.* If you find waveform voltage at the input end of a coupling capacitor, but no voltage at the output, you have saved a lot of time over trial-and-error component replacement.

The AM generator

Ordinary signal generators often gather dust on the shelf, instead of saving time at the bench. We know, of course, that an rf generator provides a quick check for a dead local oscillator, although we sometimes overlook this basic test. If a TV receiver has appreciable snow in the raster, but no picture, there may be a defect in the local-oscillator circuit. To check, merely connect the "hot" lead from an AM generator to one of the set's antenna terminals (Fig. 1). Use unmodulated output, and tune the generator through the nominal oscillator frequency on an active channel. If a picture pops on the screen, you know at once where to find the trouble.

If no picture appears, you can use the AM generator to find out *where* the signal stops. Pull the rf amplifier tube and inject a signal through a small blocking capacitor at the plate terminal of the socket. Set the generator for amplitude-modulated output, and tune through the channel to which the receiver is set. If bars appear on the screen (Fig. 2), the trouble is in the input circuitry of the tuner. You can make a similar test at the mixer plate. If the first test gives no bars, tune the generator to the receiver's i.f. when testing at the mixer plate. These three simple tests often save a lot of time in localizing trouble.

Though you might sometimes think that a signal could be injected conveniently at the "looker" point (TP in Fig. 3), this is not practical. A series resistor (such as R) is often present. This resistor creates a low-pass filter action which effectively kills a high-frequency signal. Such test points are suitable for measuring dc voltages only.

Remember to clamp the agc line to eliminate the possibility of agc trouble, which might be biasing the rf amplifier to cutoff. When no snow appears in the raster, the agc voltage

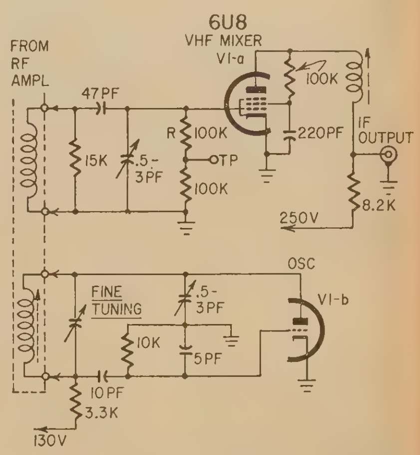


Fig. 3—Resistor R, together with stray capacitance, attenuates any rf signal injected at TP.

should always be checked or clamped at the outset. But if the no-snow symptom persists, use the AM generator and a blocking capacitor to inject signals step by step through the i.f. strip. Use amplitude-modulated output, and tune the generator to the receiver's i.f. When you come to the first "live" stage, a bar pattern will appear, as in Fig. 2.

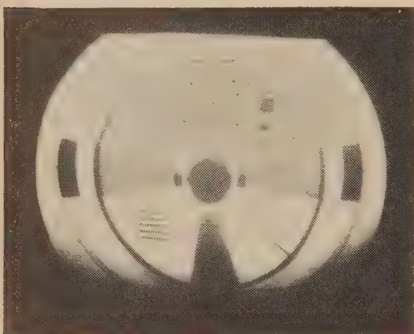


Fig. 4—60-cycle raster shading.

Use your scope

Even a low-priced scope can save a vast amount of time at the bench. For example, suppose you are tackling a symptom of raster shading (Fig. 4). This might be power-supply trouble, but there is no evidence of picture pulling in this example. And if the symptom persists after bridging the filter capacitors, what then? Since the brightness variation is from top to bottom of the screen, a spurious 60-cycle voltage must be getting in. It is time to reach for the scope. Dc measurements will get us nowhere.

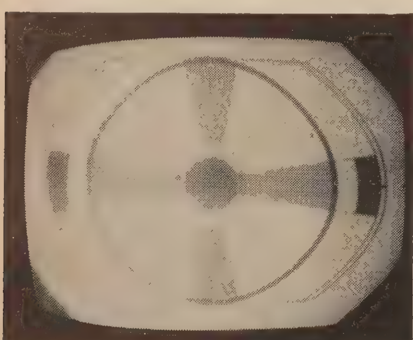


Fig. 5—15,750-cycle raster shading.

Set the scope for 30-cycle deflection, and check the waveforms at the picture-tube socket terminals. One of the dc supply lines may have a large sawtooth voltage. Or the video signal may be riding on a sawtooth base line. The sawtooth (or distorted sawtooth) is the tipoff. Follow back through the defective circuit, and you will find the trouble—it's usually a faulty decoupling capacitor in the vertical or the vertical-and-horizontal sweep sections.

The same test principles apply when shading varies from left to right (Fig. 5). In this situation, a spurious 15,750-cycle waveform is gaining entry to the picture tube. Set the scope for 7,875-cycle deflection, and check the waveforms at the picture-tube socket terminals. Determine which lead is feeding in the spurious waveform, and follow back through the defective circuit—you will usually spot a defective decoupling capacitor. I tackled this symptom a while back in a chassis that had been dubbed a tough dog by another shop—which did not have a scope. *I fired up my scope, and luck was with me—in less than 2 minutes I tracked a spurious sawtooth down to a buried electrolytic.*

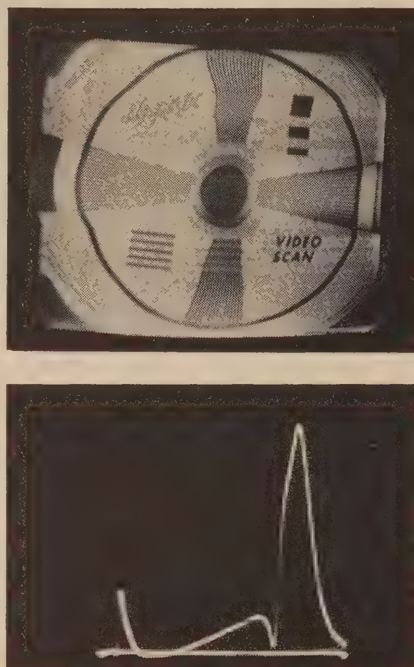


Fig. 6—Smeared picture, sync pulling and poor low-frequency response (top) are all due to serious misalignment (bottom).

Shading modulation voltage

A few picture-shading problems are trickier. For example, the video signal might not be riding on a sawtooth, but instead might be modulated along both top and bottom by a sawtooth (or distorted sawtooth) voltage. In such case, the trouble must be tracked down in the signal circuits. When sawtooth *modulation* is encountered, the raster itself is uniformly bright. But as soon as a picture signal is applied, the shading symptom appears. First, use a low-capacitance probe and check the agc line to see if it is feeding an ac waveform to the rf and i.f. sections. A defective agc filter can result in a substantial 15,750-cycle "sawtooth" waveform.

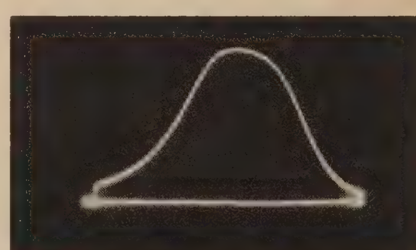
If the agc section is cleared in the scope test, check each dc supply line to the rf and i.f. sections. At one or more stages you are sure to find a spurious ac voltage with the dc. The scope will then lead you to the circuit defect that is making pulsating dc out of supposedly pure dc. It's usually an open capacitor which no longer decouples a branch circuit as the manufacturer intended it to do.

Poor frequency response

Test equipment can save much time in troubleshooting poor frequency response. Fig. 6 shows a symptom of picture pulling, smear and vertical wedges with higher contrast than horizontal wedges. Readjusting the fine-tuning control slightly tore the picture up completely. This threw suspicion on the i.f. amplifier, rather than on the rf section or video amplifier. It was time to set up the sweep generator and scope to find out for sure.

A check of the i.f. response curve immediately verified the picture analysis. The curve was highly peaked, had far too little bandwidth and displayed a severe suckout at the low-frequency end. Preliminary attempts at alignment changed the curve shape, but failed to bring it anywhere near normal shape and bandwidth. At least one i.f. stage was defective, but which? A stage-by-stage check was in order.

Response of the third stage was checked first, and looked about normal. As shown in Fig. 7, this curve has reasonable bandwidth, a broad top and no suckouts. However, a sweep signal applied at the input of the second i.f. stage displayed a very poor curve which could not be corrected by the slug adjustments. Now I knew that the trouble was in the second stage. An open capacitor? Replacing the bypass capacitors made no change.



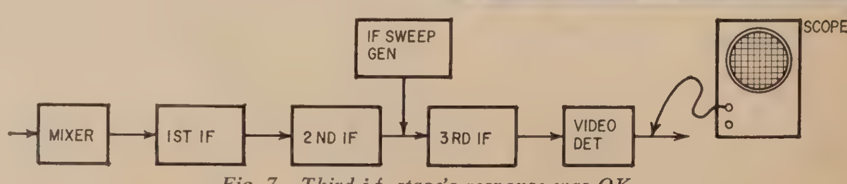


Fig. 7—Third i.f. stage's response was OK.

I concluded that the i.f. transformer must be the culprit. Disassembling and inspecting it pinpointed the defect: a growth of corrosion between the turns at the end of the secondary. Replacing the transformer and doing a complete i.f. alignment resulted in a good-quality picture. Screwdriver mechanics might argue that the trouble would have been found eventually, if a sweep generator and scope hadn't been used. But the important question is: how long is "eventually"? *Unquestionably, the instrument approach did save time—and time is money.*

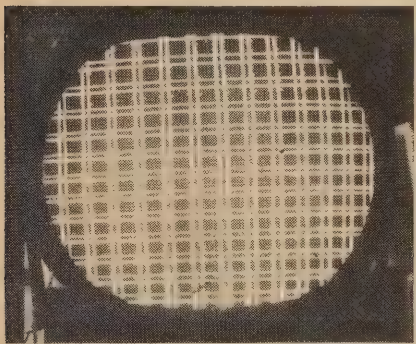


Fig. 8—Misconverged crosshatch pattern.

The color bit

Have you tried to converge a color picture tube on a station signal? If you have, you are already sold on crosshatch or dot generators. It just can't be done otherwise. Fig. 8 shows a crosshatch pattern on a misconverged color picture tube. Crosshatch is generally preferred for preliminary convergence, with a switch to a dot pattern for final trimming. Fig. 9 is an example of a badly misconverged dot pattern. You might prefer to use dots or crosshatch exclusively. This is quite practical. It's chiefly personal preference.

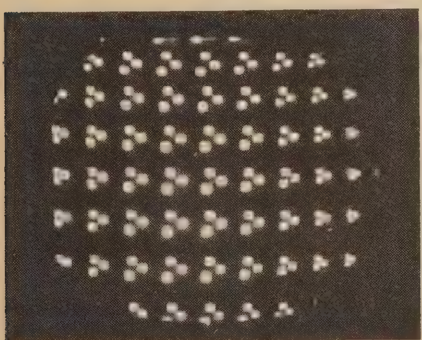


Fig. 9—Misconverged dot pattern.

Loss of color signal can be vexing and time-consuming unless you use a wide-band scope. With a good scope, you can start at the video detector output and trace the chroma signal step by step all the way to the picture tube. Fig. 10 shows a color TV station signal at the output of the video detector. You can't pick out the chroma from the black-and-

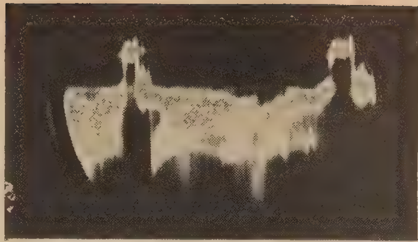


Fig. 10—Color TV station signal.

white camera signal, but the color burst on the back porch of the sync pulse shows that the chroma is coming through.

Next, a check at the output of the bandpass amplifier will show whether the chroma is getting through it (Fig. 11). You could do a lot of guesswork here and waste time without a wide-band scope. If you use a color bar gen-

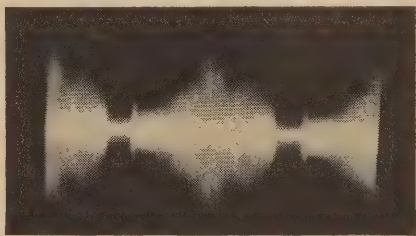


Fig. 11—Output from bandpass amplifier.

erator, the waveform will be much cleaner, and will stand still on the scope screen. Fig. 12 shows the normal appearance of R — Y and B — Y signals at the bandpass-amplifier output. Of course, if you find little or no waveform voltage here, stop right there and start checking dc voltages, resistances and capacitances.

Check bandpass alignment last. Unless a screwdriver mechanic has been at work, it is not likely that loss of chroma will be due to poor frequency response. When you do check alignment, a demodulator probe must be used with the scope (Fig. 13) to display the response curve in standard form. A video-frequency sweep generator is also required; it must sweep over a range of about 1.5 to 4.5 mc.

The next check for a no-color complaint is at the input of the chroma demodulators. Both the output from the bandpass amplifier and from the subcarrier oscillator must be fed in here. A

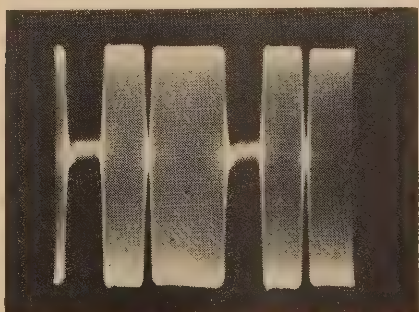


Fig. 12—Color bar signals—R — Y and B — Y.

wide-band scope will display the 3.58-mc oscillator signal as a sine wave, if it is arriving. If the signals are normal at the input, check the outputs of the chroma demodulators. Fig. 14 shows a typical pattern obtained when an NTSC generator is used. Although you can use a color TV station signal to determine whether a demodulator is working or not, it is impossible to make demodulator adjustments without a color generator of the rainbow or NTSC type.

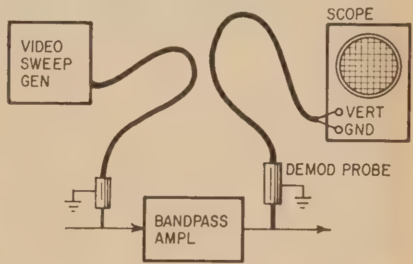
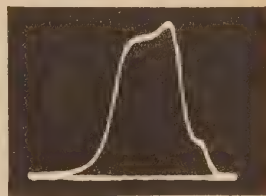


Fig. 13—You must use a demodulator probe to check bandpass frequency response.



If necessary, trace the chroma signal through the following amplifiers to the picture tube. Chroma signal tracing is basically no more difficult than i.f. signal tracing, except that you must know how color circuits work. *It is almost unbelievable that a shop would tackle color TV service without a wide-band scope and color bar generator. Yet, it does happen. A shop in Southern California tried it, and one of their early jobs was a no-color complaint. Using only black-and-white test equipment, the job took nearly 2 weeks before a cold-solder joint was found almost by accident in the chroma circuitry.*

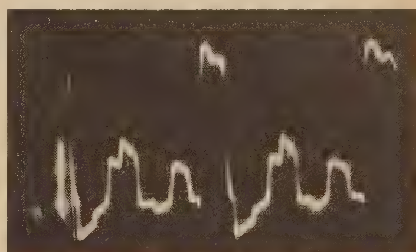


Fig. 14—Output from chroma demodulator shows distorted waveform.

In conclusion, test equipment does not cost—it pays. Any shop in business to make money cannot compete without a full complement of time-saving tools. Electronic servicing is an exacting profession, which demands both professional knowledge and professional equipment. END

Get livelier baby pix with this electronic birdie

BABY FLASH

By MELVIN S. LIEBERMAN

HAVE YOU EVER NOTICED THAT BABIES open their eyes wide and look in the direction of the flash when a flash picture has been taken? Unfortunately, this happens after the exposure has been made, and so you miss one of the best possible baby poses. By using a pre-flash technique, you can bring about a good pose which can be captured with the picture-taking flash. This unit was designed for that purpose. You will notice a great improvement in the quality of your pictures when you use this pre-flash technique.

This "Baby Flash," or electronic birdie, is very simple and can be built for about $21. Its cost will quickly be covered from a stepped-up good-picture to poor-picture ratio.

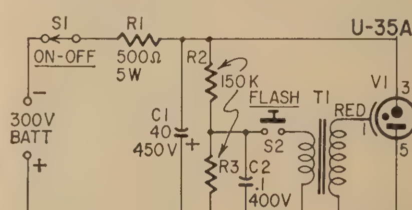
The unit is small enough to be hand-held (3 x 4 x 5 inches). The flash switch is positioned so that you can press it with your right thumb while you hold the unit. You can direct the baby's gaze merely by flashing the unit from the point at which you want the baby to look. The photographer, or an assistant, can operate this unit.

If you wish, you may mount this unit on your camera with a simple bracket. Fire the Baby Flash manually to strike a pose and then shoot a picture with your camera, firing the picture-taking flash.

I used a stroboscopic tube because it was cheap, because I wanted to flash the unit in quick succession at times and because I needed only a few watt-seconds. I built the unit in a Bud Minibox. The finished Baby Flash has a rating of 1.8 watt-seconds, which is more than adequate. The U-35A tube can be used up to 100 watt-seconds.

When the unit is turned on by switch S1, capacitor C1 charges to 300 volts through R1, the de-ionizing resistor (Fig. 1). Charge time is very short. Resistors R2 and R3 divide the voltage and allow capacitor C2 to charge to 150 volts. When pushbutton S2 is pressed, capacitor C2 discharges through the primary of T1, producing a 3- to 5-kv pulse in the secondary winding, which is connected to the grid of V1. This pulse voltage starts the ionization of V1; thereafter, capacitor C1 supplies current to V1 through terminals 3 and 5. The current from C1 produces a brilliant flash. (Terminals 3 and 5 can be interchanged —polarity is not important.)

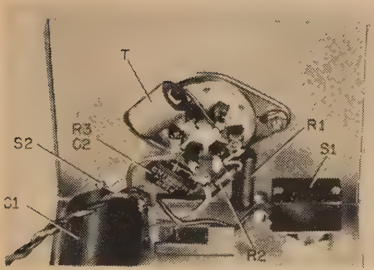
Your junior assistant can be in charge of this.



Circuit of the Baby Flash.

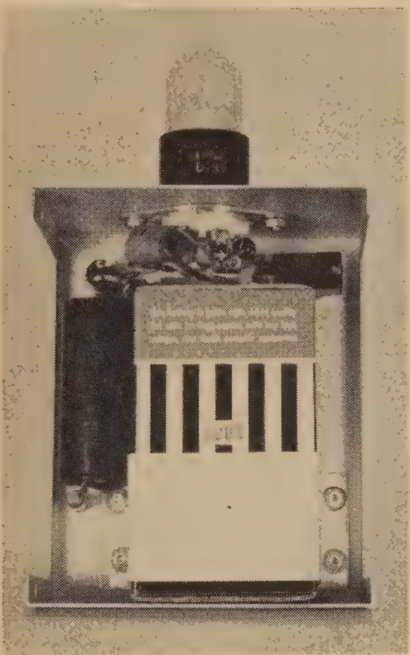
If you like, add a camera sync plug to this unit and use it for tabletop photography or photomicrography, since at closeup ranges only a low watt-second value is needed. There is room in this box to parallel two additional capacitors with C1. With 120 μf for C1, the flash rating would be 5.4 watt-seconds.

Terminal 4 of the tube socket was



Location of the parts. None of the wiring is critical, and can be finished off in a few minutes.

used as a tie point for the junction of R2, R3, C2 and one side of switch S2. Terminal 6 of the socket was used as a tie point for the other side of S2 and one of the primary leads of T1. None of the wiring is critical, and any arrangement may be used.



Instrument is completely self-contained. The case has room for even the battery.

R1—500 ohms, 5 w
R2, R3—150,000 ohms, ½ w
C1—40 µf, 450 volts, electrolytic (Cornell Dubilier Type BR 40-450 or equivalent)
C2—0.1 µf, 400 volts
S1—SPST switch
S2—N.O. pushbutton (Grayhill 23-1 or equivalent)
T1—Ignition transformer (Amglo ST-25)
V1—Stroboscopic tube (Amglo U-35A)
BATT—Battery, 300 volts (Burgess U200)
Minibox, Bud CU-3005-A
Socket, 6 pins
Aluminum strip for battery bracket
Battery plugs
Miscellaneous hardware

I've found this Baby Flash an invaluable accessory to my photograph paraphernalia. The power drain is very small, so the battery will last just about its normal shelf life.

Here's wishing you good baby-picture taking! END

What's Your Eq?

Conducted by E. D. CLARK

Three puzzlers for the students, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y. 10011.

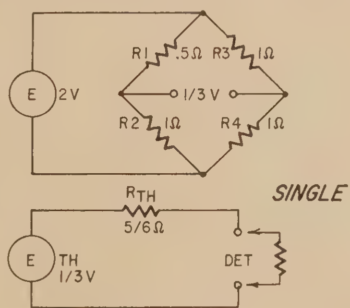
Answers to this month's puzzle are on page 95.

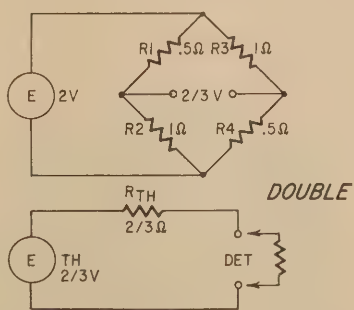
Double Bridge Sensitivity

Mr. E. D. Clark, our EQ editor, comments on the item of the above title which was on page 36 of the June issue:

A bridge with two variable arms will yield double the output of a bridge with a single variable arm, if the detector has infinite resistance. If the detector is a current-operated device such as a d'Arsonval voltmeter or ammeter (that is, *doesn't* have infinite resistance), the output ratio is *greater* than 2:1!

Using the same values as in the original EQ and reducing each circuit to its





Thevenin equivalent, we get simplified schematics like the ones in the diagram.

For instance, a 1-volt 100-ohm-per-volt voltmeter or 10-ma (100-ohm) milliammeter would yield the following readings:

$$\frac{1/3}{100+5/6} = \frac{2}{605} \text{ amp, or } \frac{200}{605} \text{ volt}$$
(single)

$$\frac{2/3}{100+2/3} = \frac{2}{302} \text{ amp, or } \frac{200}{302} \text{ volt}$$
(double)

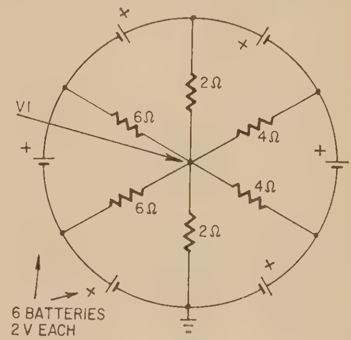
The ratio is slightly greater than 2:1. Now, going to the extreme, using a "perfect" (zero-resistance) ammeter:

$$\frac{1/3}{5/6} = 0.4 \text{ amp} \qquad \frac{2/3}{2/3} = 1 \text{ amp}$$
(single) (double)

The output ratio is now 2.5:1.

Ferris Wheel

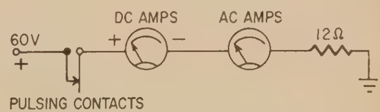
This network has six resistors connected as shown to six independent 2-



volt sources (considered ideal). What is the voltage at the junction V1?—*E. D. Clark*

Two Meters

The diagram shows a series circuit which includes two pulsing contacts, a dc ammeter (d'Arsonval type), an ac ammeter (rf type), and a 12-ohm resistor. The circuit has a total dc resist-



ance of 12 ohms and no residual reactance. If the contacts are adjusted to open and close at the rate of 60 pulses per second, and pulse width is 2/300 second, what reading will be shown on each ammeter?—*Kendall Collins*

50 Years Ago

In Gernsback Publications
In November, 1914
Electrical Experimenter

High Voltage Discharges Thru Vacuum Tubes.
A Simply Made Loading Coil, by Stuart Sandreuter.
Crystal Detectors and Electrothermal Action, by Dr. W. H. Eccles.
Making a Hot-Wire Ammeter, by H. Caine.
How to Recharge Dry Cells, by Leo J. Prindiville.

WHEN IN DOUBT, CALIBRATE!

Keep your meters at their rated accuracies without breaking into the National Bureau of Standards. Just a mercury cell, a few precision resistors and a power supply will do.

BY R. N. CENTERVILLE

TODAY, ELECTRONIC TECHNICIANS, LABoratory workers and experimenters must calibrate their test equipment accurately. How much accuracy do you need? And how can you calibrate your instruments to the necessary accuracy? Accuracy is relative. Laboratory standards are higher than service standards. Laboratories may use primary standards, while service shops will generally use secondary standards.

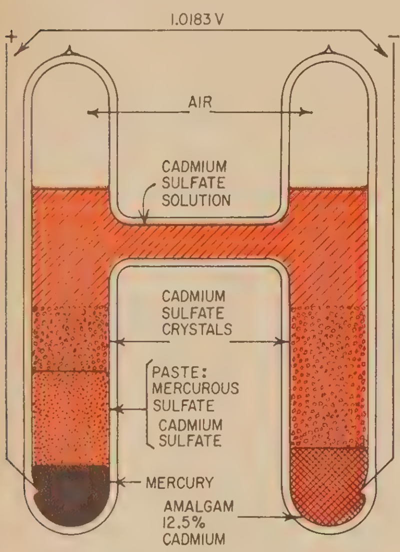


Fig. 1—What's in a Weston cell.

The primary standard of voltage is the Weston cell (Fig. 1), used in laboratories. It has an emf (source voltage) of 1.0183 volts at 20°C. The cell is customarily balanced against a variable-voltage source, to avoid drawing current from it. If the cell supplies appreciable current, its terminal voltage decreases because of polarization. After the cell stands idle, its terminal voltage will return to 1.0183.

Any voltmeter calibrated from a standard cell is called a secondary standard. This term implies that there is necessarily a calibration error, though it might be very small.

Calibrated voltmeters are widely used as secondary standards in laboratories and shops. A high-quality dc voltmeter of this type has a rated accuracy of 0.1% of the full-scale reading and costs $345. If a lab technician is satisfied with a rated accuracy of 0.5% of full-scale reading, a single-range (300 volts) laboratory type dc voltmeter can be purchased for $55. But a color TV receiver can be serviced satisfactorily if dc voltages can be measured to an accuracy of ± 10%.

Dc "standards" for shop use

Most mercury cells have an emf of 1.357 volts. They are good as voltage references. A few mercury cells are manufactured with a manganese-dioxide blend and have an emf of 1.4 volts (the voltage is marked on the cells) these are less desirable as voltage-reference cells. You can make direct emf measurements on mercury cells with vom's and vtvm's, because the effects of polarization are negligible at small current drains. If a mercury cell has occasional drains up to 1 ma, its terminal voltage will still be within 1% of 1.357 volts after several years. After 3 years, aged mercury cells have a long-term stability as accurate as 0.1%.

Since most service vom's and vtvm's are rated for an accuracy of ± 3% of full scale on dc voltage ranges, mercury cells are quite adequate voltage references. One mercury cell is used to check the first dc voltage range. If the reading is off by more than 3%, either the meter movement is defective, or a multiplier resistor is bad.

If the scale reading is still off after the multiplier is cleared, the meter movement is the culprit. Defective meters should be returned to the factory or to a repair depot. They usually read low, because the permanent magnet has lost flux (possibly from excessive jarring) or because the pointer has been bent by accidental overloads. Zener-diode protection for vom movements is cheap and worth while. Accuracy is affected only a small fraction of 1% by the diode.

Checking the higher dc ranges

Higher dc voltage ranges can be checked by using mercury batteries instead of a single mercury cell. This is economical only for the second, and possibly the third, range. Hence, a bench power supply may be used, with its output voltage calibrated against a mercury cell (or battery). Fig. 2 shows how to do this. In this example, a vom is under test. Suppose it is a 20,000-ohm-per-volt instrument with a 2.5-volt first range, and you wish to check its 250-volt range. Since the reciprocal ("1 over the . . .") of full-scale current equals the ohm-per-volt value, the vom will draw 50 μa at full scale on each range.

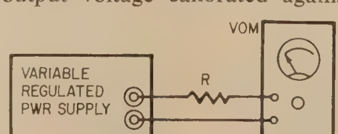


Fig. 2—Precision resistor R checks high ranges by allowing you to measure a high voltage accurately on a low-voltage scale. Then you set meter to high-voltage scale and measure again without resistor. Same reading?

You have checked the first range against a mercury cell, and found it to be accurate. Now set the power supply in Fig. 2 to 250 volts, using the 2.5-volt range of the vom and a series resistor R. The input resistance of the vom is 50,000 ohms on that range (2.5 × 20,000 ohms). Hence, R must have a value of 4.95 megohms, by Ohm's law, to give a current flow of 50 microamperes with 250 volts applied. Make up the 4.95 megohms from series-connected 1% resistors. A ¼-watt size is ample.

Set the power supply for full-scale indication on the 2.5-volt range of the vom. Now you know that the power supply is set accurately to 250 volts. Measure this voltage directly (without the resistor) on the 250-volt range of the vom. If the reading is unsatisfactory, the associated multiplier resistor(s) must be replaced.

The same general application of Ohm's law can be used to check any dc voltage range of any vom, including 1,000- or 100,000-ohm-per-volt instruments. Just be careful of your arithmetic and decimal places. With a vtvm, arithmetic is simpler, because the input resistance is the same on all dc ranges.

Checking ac ranges

Mercury cells and bench power supplies are just as useful for checking the ac voltage ranges of a vom. The ac reading is related to the dc reading. After the dc voltage indication is known to be accurate, you need merely to check ac scale readings from a known reference dc voltage, using a suitable scale factor.

What is the scale factor? If your vom uses a half-wave instrument rectifier (check the manual), the ac scale will normally read 2.22 times the dc scale reading. If your vom uses a full-wave rectifier, the ac scale will normally read 1.11 times the dc scale reading. For example: a vom with a half-wave instrument rectifier reads 1.35 volts when tested with a mercury cell on the dc voltage function; you will expect to read

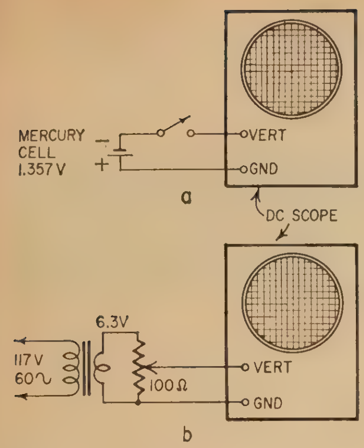


Fig. 3-a—Mercury cell across dc-scope input terminals deflects beam. In (b), sine wave is adjusted for same deflection peak to peak. Now you know the exact peak-to-peak value of the sine wave.

3 volts when the vom is switched to ac.

Remember that the dc voltage must be applied in proper polarity for the half-wave rectifier. If you use the wrong polarity, the meter will read zero, or possibly a small reverse voltage. Simply reverse the test leads. If your vom has a full-wave rectifier, you should measure 1.11 times the dc voltage, with the instrument set to ac, and the reading should be the same when the test leads are reversed. If readings are not correct both ways, one or more of the rectifier sections are defective.

When you use a power supply to check the higher ranges, remember that the input resistance of the vom is less on ac than on dc—it might have a 1,000- or 5,000-ohm-per-volt rating on ac ranges. Enter the correct value in your Ohm's law calculations.

Vtvm on ac

When calibrating the ac ranges of a vtvm, an intermediate step is required because those ranges do not respond to dc. An accurate ac source is required. If you have a good dc scope, a convenient method of comparing dc and ac voltage is shown in Fig. 3. When the switcn is closed (Fig. 3-a) the scope base line deflects up or down, depending on polarity (Fig. 4). The deflection corresponds to the voltage of the mercury cell. Next, apply an adjustable ac voltage (Fig. 3-b). Advance the input until the sine-wave deflection is the same height as the previous dc deflection (Fig. 5). Then the peak-to-peak ac voltage is equal to the reference dc voltage.

Fig. 5—Mark line where dc-deflected beam came to rest; then adjust ac peaks to same level.

Finally, apply this ac voltage to the vtvm and observe the peak-to-peak scale reading. If the reading is not the same as the reference dc voltage, the vtvm is out of calibration. Consult the manual for the location of the ac calibrating control(s), and make the necessary adjustments. Since you are working with peak-to-peak values, the waveform provided by the transformer in Fig. 3-b is of no concern. However, calibration accuracy depends directly on the scope's accuracy. In other words, unless the scope's sensitivity is the same for dc as for 60-cycle ac, there will be a calibration error.

A quick check for equal ac and dc sensitivity in a dc scope: with the circuit shown in Fig. 3-a, use a key (preferably a "bug") as the switch. Then, make a series of rapid dots, and observe the "pulse" pattern on the scope screen. The pulses should be deflected exactly to the same height as that produced by steady dc deflection (Fig. 4). However, if the pulses are deflected to a greater or lesser height, the scope is not suitable for calibration. In this test, the steady dc source is "chopped" into an ac pulse waveform. It gives a critical test of dc vs. ac sensitivity.

Fig. 4—You can easily measure the exact distance the beam travels from its normal no-input resting place.

Ohmmeter check

After the vom or vtvm has been checked on its dc and ac functions, test the ohmmeter function. This is very simple. All you need is a few 1% resistors. It is good practice to check the center-scale indication of the ohmmeter on each resistance range. A typical vom has three resistance ranges, with center-scale values of 12, 1,200 and 120,000 ohms. On the other hand, a typical vtvm has seven resistance ranges with center-scale values of 10, 100, 1,000, 10,000, 100,000, 1,000,000 and 10,000,000 ohms. If an ohmmeter does not indicate reasonably accurate resistance values, the internal battery may be weak, or the multiplier resistors may be off value.

Rated accuracy of an ohmmeter is based on its rated accuracy for dc voltage indication. For example, the vom or vtvm might be rated for an accuracy of $\pm 3\%$ of full-scale indication on dc volts. Accordingly, there will be a "spread" of 15 volts on the 250-volt range. This is the rated "arc of error," which applies also to the accuracy of ohmmeter indication. We have to use "arc of error" because the ohmmeter scale is nonlinear. Fig. 6 illustrates this. Of course, the arc of error for a particular instrument might be different from the example of Fig. 6. Check the manual for the accuracy rating of your instrument.

Milli- and microammeters

It might seem simple to check the accuracy of a vom on its current ranges. Basically, it is simple. However, the beginner often overlooks the fact that a milliammeter or microammeter has a different input resistance on each range. This must be taken into account in most cases. Fig. 7 shows the test setup for checking accuracy. A 1% resistor R is connected in series with a mercury battery and the vom. The current flow is given by Ohm's law. Observe that the total circuit resistance consists of R plus the internal resistance of the vom.

This internal resistance might be given in the instrument manual. If it isn't, check the circuit on the range to be calibrated. For example, Fig. 8 shows the circuit for a vom on its 100-μa range. The input resistance is 2,500 ohms. If a 1.35-volt mercury cell is used in the Fig. 7 configuration, the to-

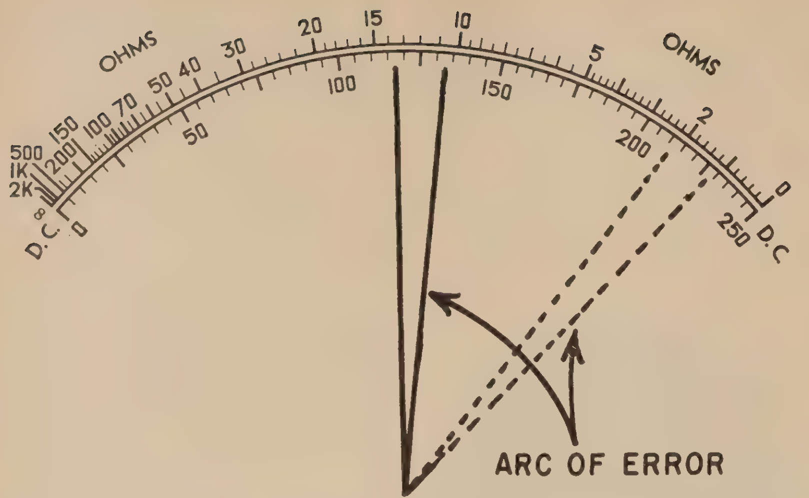


Fig. 6—Arc of error on ohmmeter scale is determined by total plus-and-minus dc voltage error. Note how same-size arc covers about 3 ohms at center scale, only about 1 ohm at right.

tal circuit resistance must be 13,500 ohms for full-scale indication. Since the vom has 2,500 ohms input resistance, R must have a value of 11,000 ohms. If you forgot the input resistance of the vom, you would conclude falsely that the meter was seriously in error.

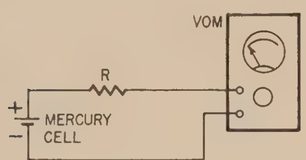


Fig. 7—Test setup for checking current-scale accuracy.

Ammeter checks

High-current ranges of a vom cannot be so easily checked in the shop. Small cells or batteries have an internal resistance which cannot be neglected when substantial current is drawn, and low-resistance "standards" are not readily available nor are they easy to work with. Fig. 9 shows how a battery must be regarded as connected in series with an internal resistance when comparatively large currents are drawn. The value of that resistance is not constant. It varies with the current value, and with the time the current flows.

You can use a storage battery as a "standard" voltage source, by measuring its terminal voltage with a calibrated dc voltmeter. However, note that, if you use a 6-volt battery, the total circuit resistance for a 10-ampere flow will be 0.6 ohm. The input resistance of a typical vom on its 10-ampere range is .025 ohm (Fig. 10). The "standard" resistance will accordingly have to be 0.575 ohm for a 10-ampere deflection. You can see that lead resistance, contact resistance and internal resistance of the storage battery can all be significant in this situation.

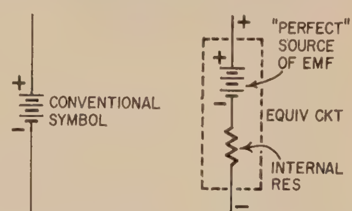


Fig. 9—Usual battery symbol doesn't tell all. In series with every battery's emf is an internal resistance that depends on design of battery, its state of charge, its age, temperature, amount of current being drawn, etc.

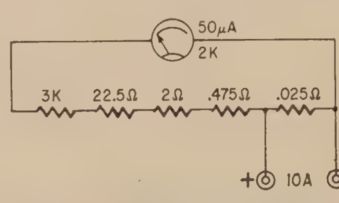


Fig. 10—Circuit of a vom switched to 10-ampere dc range.

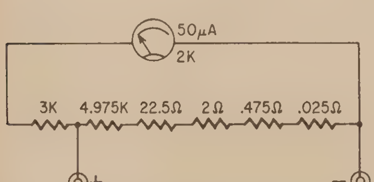
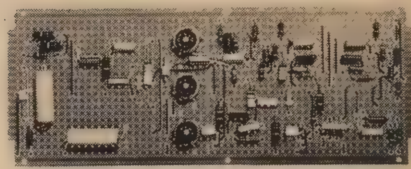


Fig. 8—Circuit of a vom switched to 100-μa dc range.

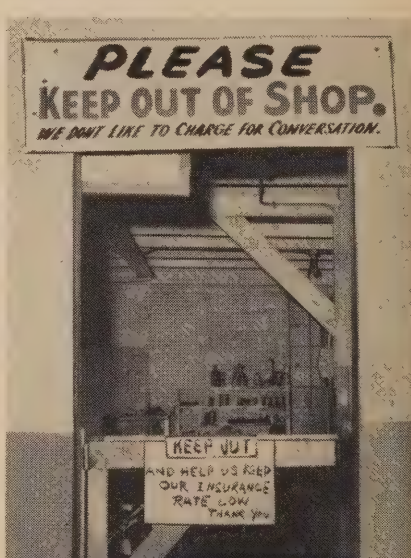
For a rough check of high-current indication accuracy, connect two (or more) ammeters in series, and hook the combination into a high-current circuit to see whether their indications agree reasonably well. If both instruments read about the same, the probability is rather good that both are accurate. This method eliminates any error from circuit resistance, because the same current, whatever it might be, flows through both instruments. END

New Circuit Board Is Ready-Printed



An interesting new circuit board for designers and experimenters, introduced by Vero Electronics of Farmingdale, N.Y., makes it unnecessary to etch your own board. The board already has a number of copper strips running its full length, pierced with enough holes to make it possible to mount any component. By laying out a diagram on a special design sheet, it becomes practical and simple to make up your own printed circuit layout. The board can become more useful by paralleling two or more strips for ground or high-voltage buses, and by drilling holes to interrupt break copper strips, making it possible to use portions of the same strip for different purposes.

An Appeal to Reason



Service shops of all kinds everywhere are plagued with curious, friendly, chatty people who wander about poking at things and asking questions of the technicians. This can be a distracting nuisance to them, as well as a potential danger to the visitor.

The photo shows the polite but unmistakably firm approach used by our shop to keep customers from getting mixed up with the tools and chassis. *—Harry J. Miller*

COOKING UP AN AMPLIFIER

Ground rules for designing your own little general-purpose amplifier

By JACK DARR
SERVICE EDITOR

EVERY TECHNICIAN OUGHT TO BE AS FAmiliar with the circuit below as he is with his own signature! Why? Because it's the basic foundation on which nearly all audio amplifiers are built. Parts values and tube types change, but this circuit will always be in there somewhere.

How can you use it? Well, say we need a small amplifier for a certain job. We figure out what we need, then set it up accordingly. For example, we want 5 watts power output. This being the first thing, we look in the tube book to find a tube that will give us that. How about a 6V6? There are several other types, but this is about as common and cheap a tube as we can find. Rugged, too. (A 6AQ5 is the seven-pin miniature version of the 6V6, also usable.) According to the tube book, it'll give us 4.5 watts with 250 volts on plate and screen. Near enough. Our power supply has to furnish this, at a maximum of 54 ma, so we set this up for at least 65–70 ma so that we have a generous safety factor.

Output transformer? Pick it to fit the job, from any catalog. A 6V6 has a 5,000-ohm recommended load impedance; say we're going to use an 8-ohm speaker. That's all we need. Look for a transformer listed as "5,000 ohms to 8 ohms, 5 watts."

Now, we set up the bias. Book says 12.5 volts for this amount of output. So, at a nominal 50-ma total plate and screen current, a 250- (or 220- or 270-) ohm resistor (R5) will give us 12.5 volts bias.

In the first stage, we need enough voltage amplification to build up the input to the right amount to drive our 6V6 to full output. Class-A, with 12.5 volts bias, we can use a maximum peak-to-peak signal voltage of 25. (Bias voltage, doubled.) This is a maximum value, remember, so we could get by with a bit less. However, voltage amplification isn't hard to get.

Let's say our input will be from a phono cartridge that has an output of about 1 volt. So, we need a minimum amplification of 25. Well, how about a 6AV6—another good, common, cheap tube. Book says, 100 volts plate, −1 volt on the grid, and, with the right plate load, we'll get voltage gain near 100 (theoretically). Good! Might have some left over! For such a high-μ triode, we want to use a high plate load (R3) to take advantage of the gain available. So we use (on general good-practice principles) a resistor of 100,000 ohms or higher.

The 6V6-GT grid resistor (R4) is effectively in parallel with the 6AV6 plate load (the coupling capacitor here is always large enough to have very small reactance at mid-frequency. It can be neglected in this formula, the two resistors being figured as if they were in parallel, which they are, as far as the *signal voltage* developed across them is concerned). So it should be at last 270,000 ohms.

Using the lowest values should give us a voltage gain of almost 50, and this is plenty. We can use something like a 250,000-ohm to 2-megohm pot across the input, and control the gain there. For ceramic phono cartridges, the value should be at least 1 megohm.

For a straight, simple amplifier, without any frills or feedback, the simplest kind of bias for the 6AV6 is *grid-leak* bias, which we can get just by using a high-value grid resistor, R2 (anything from 3 to 10 megohms will do). This saves figuring and wiring in a cathode bias resistor and maybe a bypass capacitor for it, but if you plan to use a volume control (R1) as shown, you must isolate its slider (for dc) with a capacitor (C1) to prevent shorting the bias voltage to ground when the slider is at minimum volume.

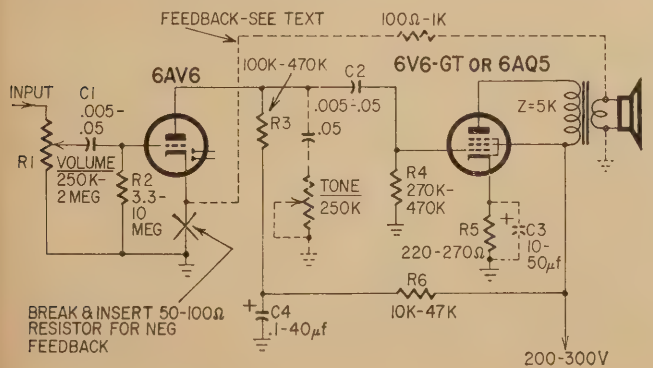
Now, there's the basic circuit. The little filter in the input tube line uses a dropping resistor (R6) big enough to hold the 6AV6 plate voltage down to what we want, and to decouple it from the 6V6 supply line. With a 1-ma plate current, even I can figure it out!

You'll lose 1 volt for every 1,000 ohms! So, with a 100,000-ohm plate load resistor, we'd need 200 volts at the bottom of it. If our B-plus is 250 volts, as we said, for the 6V6, we'll have to get rid of another 50 volts, and this makes the resistor 47,000 ohms (nearest commercial 10% value). Capacitor C4 can be any size big enough to prevent feedback: from about 0.1-μf up to about 40-μf electrolytic.

Now, we can add anything we want. More gain? Bypass the 6V6 cathode resistor with about a 25-μf electrolytic (C3). Add a high-cut tone control by hooking a .05-μf capacitor in series with a 250,000-ohm pot from the 6AV6 plate to ground. Add feedback via the dotted line from the voice coil to the cathode of the 6AV6. (If the amplifier yowls when you hook it up, reverse the output transformer secondary connections.) And on and on. This is a basic amplifier, and you can put all the refinements you want on it, but you've got build this first.

I'll admit this is what they call cookbook engineering, but you *can* whomp up some mighty tasty dishes out of a good cookbook, and the average tube manual's a pretty good cookbook.

Don't ignore the resistance-coupled amplifier charts at the back of the RCA and Sylvania receiving tube manuals. They give assortments of values for just about every tube you can expect to use as an audio voltage amplifier, and are very quick and easy to use. If you need a preamp or more elaborate tone controls, you'll find 'em in the back of the RCA manual. END



Foundation of practically all audio amplifiers: voltage amplifier drives power amplifier. Essentials are shown in solid lines; optional frills, dotted.

Service clinic

by Jack Darr
Service Editor

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

HOW ACCURATE IS "ACCURATE"? GOOD question. Like all of the others in this bewildering business, one with several answers. Our instruments are always more acurate than our *interpretation* of their readings! Let's see why.

Some people speak of "service-type" meters condescendingly, as if they weren't quite good quality. This is just not so. A good vom or vtvm, in good condition, will be accurate to within ±2% of full scale; one make even has a ±1.5% rating. What do you want? The typical "laboratory" meter has about 1% accuracy. (There is another difference besides 1% less accuracy: price. Good service vom, $50–75. Lab meter, same ranges, $550–$750!)

Plus or minus 2% of full scale on a 100-volt scale, at half-scale, means that 48 to 52 volts is within tolerance. Is this bad? No, sir! That last word gives us the clue—tolerance, the technician's friend. The equipment we work with has a *much* greater tolerance!

We measure voltage, current and resistance; most of us use combination instruments—vom or vtvm's. They'll have about the same accuracy on all functions. Read the fine print in TV and radio parts lists. Resistors, 10% or even 20%; electrolytic capacitors, −10%, +50%; paper capacitors, 10% and 20%. Even the ac input voltage is "105–120 volts"! This means, if we take "worst case" conditions, that with all tolerances leaning the same way, we could have an error in the set itself up to about *40%!* This seldom happens, of course, but it could.

So, we've got a lot of leeway in the voltages and parts values. Remember, almost all voltages in TV and radio sets are determined by dropping resistors. So they can't be more accurate than the resistors themselves. At last I'm getting to the point: with such wide tolerance in resistors and voltages, *we don't need lab quality instruments to measure them!*

"Error" is always given as percentage of full-scale deflection. On a 100-volt scale, ±2% means plus or minus 2 volts; on a 10-volt scale, plus or minus 0.2 volt. Remember this while servicing, and you'll save a lot of time.

Learn to *interpret* voltage readings for what they *mean* instead of what they actually are; make a mental allowance for tolerance. What this reading *means* in terms of circuit conditions is far more important than the actual reading in tenths of a volt! If a certain tube element calls for 100 volts, and your reading is between 90 and 110 volts, go on. The trouble isn't there. Don't waste time trying to read this as "97.65 volts"! Now, if you get 50 volts or 150 volts, start looking; something *is* wrong around there. This is way beyond tolerance.

This will apply to the great majority of voltages, especially in ac-operated equipment. Transistor radios will be slightly more demanding, because of the very low voltages. But again, *percentage* error is what counts.

For maximum accuracy in ac-powered sets, make sure that the line voltage is set at exactly 117 volts. This is the "design center", and the voltage at which the readings on the schematic were taken. Check the little box down in the corner of the diagram. Also—this is one that a lot of us overlook—*most readings are taken with no signal input!* A strong input signal can alter a lot of readings, especially in agc-controlled stages, sync separator plates and grids, big amplifiers with class-AB or class-B outputs, and so on.

To get accurate readings in sensitive circuits, take them at a point where your measuring instrument will cause the least circuit disturbance. For instance, reading grid voltage on an audio amplifier tube with a vtvm won't affect things too much, because of the low frequencies. Reading grid voltage in the video i.f. will detune the stage enough so that

readings will be off. Here, read bias by measuring the cathode voltage; after all, that *is* the bias!

You can overdo things in taking meter readings, and especially in figuring. You want to figure out the value for some part. You'll read voltage, current or resistance with a 2% meter, and then take two of these and work out the third. So, you happily read your voltmeter: "87.25 volts." (Error No. 1: with a meter (full-scale) error of 2%, you're reading this to two decimal places! This implies an accuracy of .01%! Where'd you get it?) Now, you take a resistance reading as "50.75 ohms". (Same thing—Error No. 2.) You use all of these figures in your calculations and come up with an answer to *4* places after the decimal point! You now have an accuracy of .0001%. Really?

To save a lot of math, which no one likes anyhow, round off the figures. 87 volts, 50 ohms (or 51). After all, at 2%, there is some doubt even about the accuracy of the last figure *before* the decimal point! So your answer will still be well within the 10–20% tolerance of the actual circuit.

For maximum accuracy in readings, try these tips. Use the lowest possible scale, and get the reading as near to the center of the scale as you can. A d'Arsonval meter is most accurate in the middle 50% of the scale. Maximum error is in the first and last quarters of the scale.

Take your readings at points where they'll cause the least circuit disturbance, from detuning or shunting. Look for "tricks" that will let you spread out the reading and use a lower scale. For example, in reading bias on transistor radios; let's say the base voltage is 11.2 and the emitter 11.8 volts. Don't use the 15-volt scale. Read the voltage between base and emitter on a *2-volt* (or 1.5-volt) scale. 2% of 2 volts is a lot less than 2% of 15 volts. Error is always a percentage of full-scale deflection.

Cheer up. Your instruments are *completely* satisfactory for what you're using them for. After all, it's not the exact voltage reading that we want. We need a reading close enough to give us information about what's happening in the circuit! Our *interpretation* of that tells us where the trouble is!

Another mystery set

I enclose the block diagram of a TV set I have on the bench. No model number; it's a Tele-Tone. Can you tell me what model this is?—L. M. B., Towson, Md.

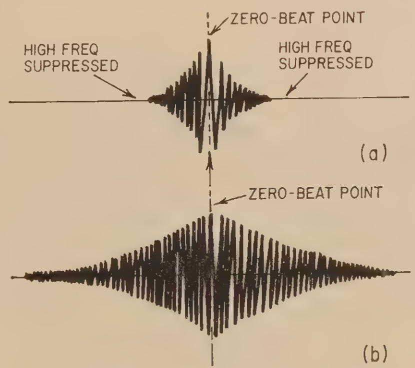
This, frankly, is a guess, but I think it's somewhere around a TV-149 or TV-259 (Sams 56-22 or 57-21, respectively). Check this out by going to your distributor and looking at the folders, comparing the chassis photos with the set.

What you'll wind up doing is what we all have to do once in a while: using a "similar" chassis of the same make. TV designers tend to use the same circuits in quite a few chassis. For example, the Tele-Tone engineers probably used the same horizontal oscillator circuit in four or five sets of the same vintage. So, if your trouble is there, look up a set made at the same time, check the tubes used, and so forth.

The Marker Adder and the Square Wave

I built the marker adder described in the July 1963 issue. Now, I've got trouble. When I feed a square-wave signal through it, the leading edges are rounded off. I've checked every part in it, but all seem to be OK.—W. G., New York, N. Y.

You're being a little bit too strict! In sweep alignment work, we do *not* need a very high frequency response. Most of the stuff we work with is actually down around 60 cycles! Even the markers themselves are actually the "low-frequency" parts of the beat between two high-frequency signals.



All we need from a marker is a narrow band of frequencies near the zero beat between marker signal and sweep signal (a). "Hi-fi" response in marker equipment lets too-high beats through, makes a fuzzy extended marker that is almost useless (b).

Then, too, a square wave is about the roughest test you can give any amplifier. Even on a 100-cycle square wave, the amplifier must be flat to far on up the line, say to at least the 10th harmonic, to avoid rounding the edges.

Notice in the article that Mr. Wiles says "Low-frequency response in the 6AU6 pip amplifier has been *purposely limited* . . ." and "High frequency response is also limited, to keep markers narrow and sharp." Remember the trick of shunting a small capacitor across a scope input to make markers sharper? Same thing. I'd say your unit's ok. END

Hallicrafter HM-1 Vacuum-tube Volt-Milliammeter

CURRENT TESTS ARE IMPORTANT IN semiconductor circuits. So important that this new vtvm kit includes current ranges of 1.5, 5, 15, 50, 150 and 500 ma (at 3% of full-scale accuracy) as well as ac and dc voltage and, of course, resistance ranges.

The milliampere ranges of the HM-1 are not part of the electronic circuitry. They can be used whether the power switch is on or off—the power cord does not even have to be plugged in.

The 500-μa meter movement is bridged by the current shunt, which protects it. This, along with the usual meter damping, protects the moving parts from all but severe physical shock.

Dc volts
Ranges: 0–1.5, 5, 15, 150, 500 and 1,500 volts full scale. Up to 30,000 volts with accessory high-voltage probe.
Input resistance: 11 megohms (1 megohm in probe) on all ranges.
Accuracy: ±3% full scale.

Ac volts
Ranges: 0–1.5, 5, 15, 50, 150, 500 and 1,500 rms scales; 0–4, 14, 40, 140, 400, 1,400, 4,000 peak-to-peak.
Frequency response: ±1 db, 25 cycles to 1 mc on 1.5- and 5-volt ranges (600 ohm source). 50 kc to 250 mc with accessory high-frequency probe.
Accuracy: ±5% full scale.
Input impedance: 1 megohm shunted by 135 pf on any scale (measured at input treminals).

Ohms
Ranges: Scale with 10 ohm-center ×1, ×10, ×100, ×1000, ×10K, ×100K and ×1MEG. Measures 0.1 ohm to 1,000 megohms with internal battery.

Dc Ma
Ranges: 1.5, 5, 15, 150 and 500.
Accuracy: ±3% full scale.
Size: 8-½ x 5-½ x 5-¾ inches.
Weight: 4-¾ lb.
Price: $29.95 kit, $59.95 wired.

Wiring this kit has been simplified by somewhat unusual terminal strips. They are similar to the ones used on some TV receivers before printed circuits became so popular with the production cost accountants.

It is not necessary to wrap the wire ends or component pigtails to secure them before they are soldered several steps later in the construction. Just poke them into the hole and they will stay there until all the other leads have been inserted. The chassis is then turned over and all the wired terminals soldered at once. Just make sure that you use enough solder and cook the joint long enough to prevent rosin joints. Poor soldering here can be even harder to locate than with conventional terminals.

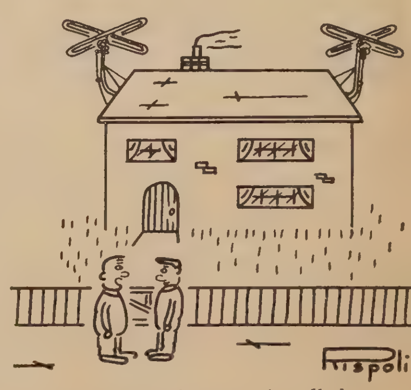
To be sure you make the correct connections the first time, be slow and careful in wiring the selector switch—you will save many hours of trouble-shooting later. It is difficult to make a mistake, if you follow the instructions completely. They are self-checking, and vari-colored wiring makes it even harder to go wrong.

One important step should not be bypassed. It is very important, and quite normal, to age the dual triode used in the vtvm circuit. Unless the tube is properly aged it may be impossible to get a constant zero reading when switching from − dc to + dc functions. Calibration will not be reliable, and it is annoying to have to zero the meter every time the function switch is rotated from one mode to another.

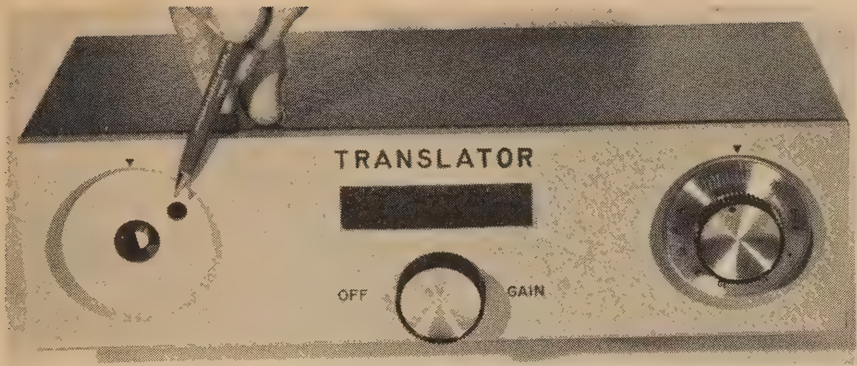
To speed tube aging, temporary jumpers are connected into the circuit. The grids and cathodes are connected together and the instrument is left on for some 60 hours.

The same results can be obtained just by letting the vtvm "cook" on the shelf without any temporary jumpers—it just takes longer.

Even if it is necessary to age the tube for a week, it is well worth the added stability of measurements made with the HM-1.—*Elmer C. Carlson*



"I believe he's just installed a stereophonic system."



Vhf fine-tuning slugs for each channel are accessible through this hole behind vhf channel-selector knob.

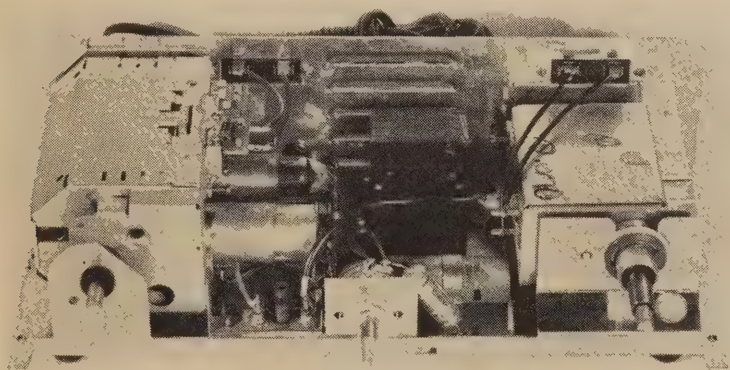
Standard Kollsman VUT-1 Vhf-to-Uhf Translator

WITH FCC REGULATIONS REQUIRING ALL TV manufacturers to install uhf tuners on sets built since last April, we are going to see an upsurge in uhf activity. More sets will be coming into our shops to be checked for uhf operation. If the local station is not yet broadcasting full-time, checking may not be easy.

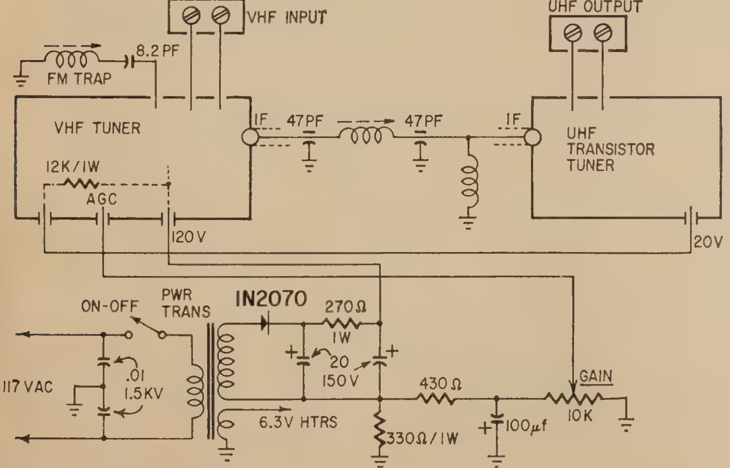
Uhf test equipment has been scarce in most shops because of the low demand and the high price. This Standard Kollsman translator is a sensible and economical answer to the problem of supplying a high-quality uhf test signal. The idea is simplicity itself and virtually foolproof. A vhf antenna lead is connected to the vhf input terminals on the translator. The vhf dial is set for an active channel in your area. The uhf dial on the translator is set to any channel from 14 to 83. A lead from the uhf terminals is connected from the translator to the uhf terminals of the set to be checked. The uhf dial on the TV is set for the same channel as the one selected on the translator.

The signal picked up from the vhf station is now converted to a uhf signal that can be picked up on a uhf receiver.

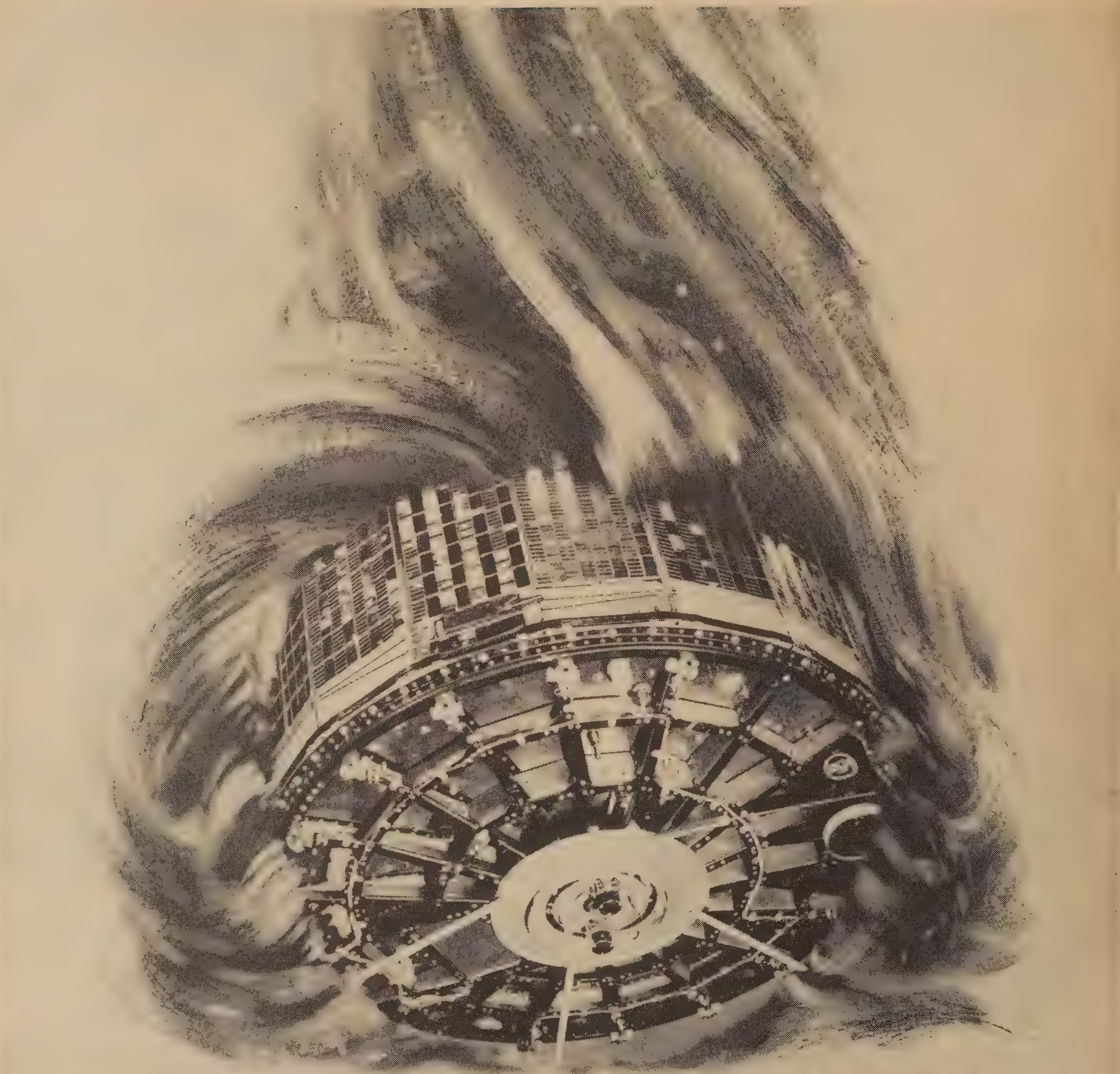
continued on page 70



Inside, vhf tuner is on left and uhf on right. Power supply is in center.



Block diagram of the VUT-1. It is hardly more than a vhf tuner, a uhf tuner and a common power supply.



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Continued from page 65

For example, you can pick up channel 3 on the translator and "rebroadcast" it to a TV set on channel 26 (or any other uhf channel).

The circuit is a sort of "backward" superhet. The vhf signal is coupled into a 12-channel vhf tuner, where it is changed to a 40 mc i.f. This i.f. is then fed to the i.f. circuit of the transistor uhf tuner, where it beats against the uhf oscillator and is changed to a uhf frequency (diagram). A gain control prevents overload by placing a variable negative voltage on the agc input to the vhf tuner. A dropping resistor inside the vhf tuner reduces the voltage to the approximately 20 necessary.

The vhf tuner has adjustable slug-tuning for each channel, accessible through a hole behind the vhf channel knob. The uhf tuner uses continuous tuning with a vernier that locks in after a small rotation to provide "speed" tuning across the uhf band. For price, see your distributor.—*Wayne Lemons.*

Precision Voltage Reference Decades

THE EMCEE PRECISION VOLTAGE REFERENCES offer an easy and accurate way to check calibration of scopes, amplifiers, meters, recorders, etc. They have a large decade scale on a sloping panel and are mounted in walnut-finished Bakelite cases. Each measures $4\frac{1}{2}$ inches wide, $5\frac{13}{16}$ inches long and $5\frac{3}{8}$ inches deep, and weighs 2 lb.

Four decades (the 1118A, -B, -C and -D) are available in separate units. Maximum values are 0.1, 1.0, 10 and 100 mv. The photo shows a 10–100-μv decade. Output is available at multiples of 10 μv in this particular unit.

All units are accurate to within 0.5%. The voltage divider resistors are rated at 0.25% and are trimmed with high-value resistors shunted across them. Each is self-contained with its own power supply, a mercury cell with life of over 14,000 ma-hr, which equals a year or more. Output resistance of each decade is extremely low. In each case it equals the maximum mv scale reading. Thus, the 10—100-mv decade has an output resistance of only 100 ohms. Readings are accurate over a temperature range of 0–40°C. Short circuits do not affect accuracy of the output.

More than one decade may be connected in series to cover a wide range. The diagram shows how to connect all four decades to measure an unknown voltage. The indicator may be any sensitive galvanometer or dc detector. Each decade is adjusted until deflections from the unknown and the reference are identical. Then the unknown is read off the dials. For example, it may be 50 mv on the first decade, 4 on the second, 0.8 on the third and .07 on the last. Then the unknown is 54.87 mv. Scopes and meters may be calibrated by connecting the four units in series and applying the total voltage across the instrument's input terminals.

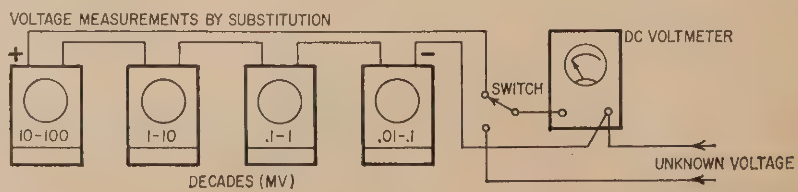
A single decade is useful for checking linearity as well as accuracy of a meter. For a microammeter, for example, the 10–100-mv decade may be connected with a limiting resistor (if necessary) in series to obtain full-scale reading. Then the decade provides a check of meter reading every 10% over the scale.

Each of the four decades is priced at $39.50.—*I. Queen*

CORRECTION

A 24–26-volt, 1-amp center-tapped filament transformer is used to power the selective photoelectric circuit on page 38 of the July issue. A Stancor F-6469 or equivalent was recommended in the parts list. Somebody goofed. This transformer is not center-tapped. The Triad F-40X is the only center-tapped transformer with these ratings that we can find in consumer catalogs.

Our thanks to Mr. John L. Van Orden of Tacoma, Washington, for letting us know that he couldn't find the center tap on the transformer specified.



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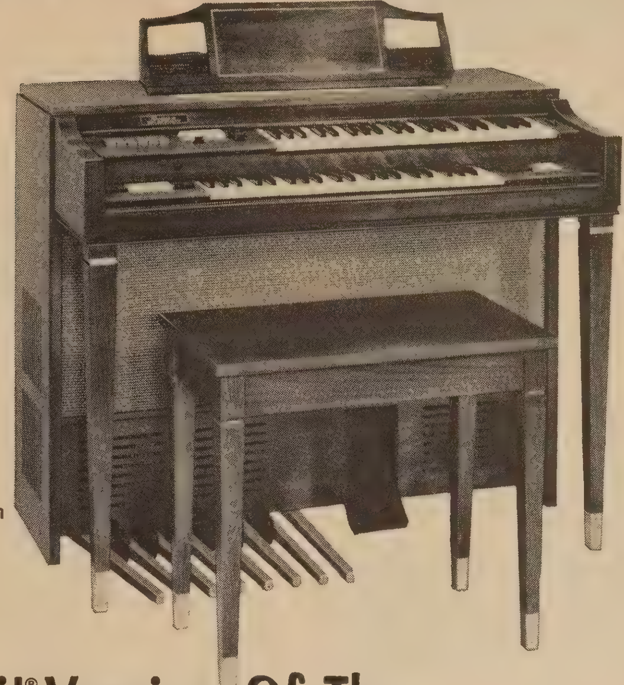

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A Professional Organist's Dream With A Beginner's Simplicity!
That's the new Heathkit/Thomas "Coronado" All-Transistor Organ with every deluxe organ feature you've ever dreamed of for complete versatility! And it's all wrapped up in a luxurious piece of walnut furniture that will be the showpiece of any home. It's all yours to enjoy at a savings that can't be found anywhere else . . . up to $449! It's like getting ⅓ off!

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You don't have to be an electronics wizard to build it, nor a professional organist to play it. Famous Heath "Engi-nuity" has reduced assembly of this magnificient instrument to simple-to-perform steps that require **no** special talents, knowledge or tools. Makes a fascinating, enjoyable project for the entire family! And the famous Thomas "Musical Fun Book" is included to start you easily playing many favorite tunes immediately. A special, recorded, 48-lesson course is also available at a **$30 savings** to provide you with a firm and lasting knowledge of music . . . lets you learn at your leisure! Before you know it, you'll be creating the sounds of an entire orchestra!

Each and every component in the GD-983 is a genuine Thomas factory-fabricated part. And its advanced all-transistor circuitry means less heat, better tone, longer life, and virtually trouble-free performance.

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4. Provides A Wholesome Creative Outlet . . . helps you unwind, forget your problems, and ease tensions.

Check the features, then send for the demonstration record and hear it for yourself. You'll agree that there's not a better organ buy on the market today than the Heathkit/Thomas "Coronado"!

Kit GD-983, Organ & matching walnut bench, 290 lbs. $849.00

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Convince yourself by sending for a 7", 33⅓ demonstration record! Order No. GDA-983-2 for Deluxe GD-983 organ, GDA-232-5 for low-cost GD-232A organ. Each record 50c. Do it now!

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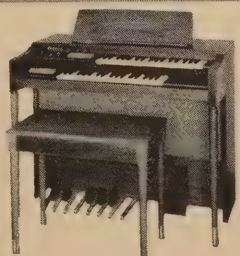

• 10 true organ voices • Variable Repeat Percussion for additional effects • Two 37-note keyboards • 13-note heel & toe bass pedals • 20-watt peak power amplifier • Walnut cabinet • Transistorized plug-in tone generators . . . warranted for five full years • Expression pedal.

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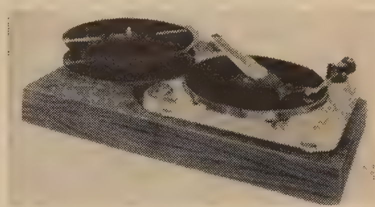
AUDIO EQUIPMENT REPORT

Thorens TD-224 Turntable and Record Changer



IT DOESN'T LOOK LIKE THE FAMILIAR "record changer." Nor does it look exactly like a "turntable." No spindle or shaft protrudes straight or eccentrically from the center of the moving turntable. And there is an unusual configuration of two "arms" extending out and away from the left side of the unit. You don't stack records above the turntable, as one usually does with a record changer. You don't lift the stack off the turntable at the end of the completed cycle of play, either. You do stack the records on the upper of the two left side arms. You do remove them from the lower side arm. How the "stack" gets from the upper to the lower side arm is a bit of automation that is fascinating to watch.

Imagine a firm but gentle hand removing an individual record from a stack alongside a turntable, placing it carefully on the turntable, waiting until the record is played, lifting it gently and placing it on another stack. Then the hand moves back to the stack of unplayed records and repeats the procedure automatically.

There are specific benefits in such a technique for playing records automatically. Never is there more than one record on the moving turntable. This enables the relationship between the stylus axis and the record being played, and between the plane of the pickup arm and the turntable's surface, to remain constant.

The result is that vertical tracking error is as small as it would be with a conventional, manually operated turntable, and is maintained constant. Record groove and stylus wear are not increased as they often are in a stacking type of player.

The turntable–changer mechanism is unusually quiet for a machine that performs so many complex functions. It takes approximately 21 seconds from the time the REJECT lever is actuated for the mechanism to raise the pickup arm automatically, remove and stack the played record, pick up a fresh disc and place it on the turntable and then lower the pickup to the starting groove. No doubt the smoothness is due to the use of ball bearings and large-diameter pillars for critical sliding and interlocking members. Extravagant use is made of castings for sections subjected to torsion and special stresses.

A further benefit of having no more than one record on the moving turntable at any time is that motor torque is constant throughout the complete cycle of playing the stack of records. This assures constant turntable speed.

A stroboscope is built into the unit. A "window" in the turntable deck just in front of the moving turntable lets you view a dot pattern by a neon lamp.

The speed adjustment is a knob placed coaxially with the 16-, 33⅓-, 45- and 78-rpm selector. The speed is adjusted only for 33⅓ rpm. The manufacturer claims that it will then be correct for the other three settings, and will be constant within 0.1%.

A cute touch is the device that cleans the records as they play. The manufacturer says that up to eight records or a ¾-inch stack can be handled. This is conservative because I repeatedly played ten 12-inch records without jamming or mechanical interference. Records of any diameter from 7 to 12 inches can be intermixed.

The pickup arm is the well known Thorens BTD-12S. Two cartridge shells are supplied. The arm is equipped with ball bearings on all axes. The pickup is electrically muted, without clicks, during the change cycle.

So often the instruction manual is terribly neglected by the manufacturer. [And by the user!—*Editor*] In this case, the manual has been given first-rate treatment. At the very beginning of the instructions a bold-face phrase asks, "Are you anxious to start playing?" Then there is an asterisk (*) and "Follow these signs for the essential instructions for installation and final adjustments before play," and a large dot (•) with, "Follow these signs for essential operating instructions."

The Thorens TD-224 is by no means small. The base (an accessory) measures 27 inches wide, 14½ inches deep, and 4½ inches high. Height requirement is 9¾ inches overall. The changer sells for $250 less cartridge. Walnut base is $25.

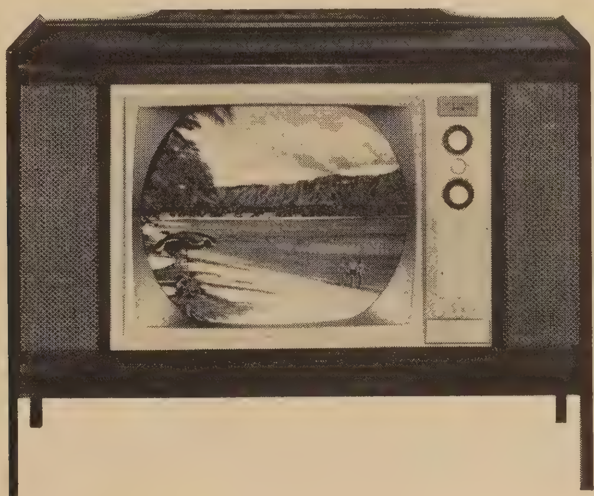
Incidentally, the TD-224 can also be operated as a manual transcription turntable. The manufacturer suggests that you handle your records as gently as the changer does.—*Leon A. Wortman*

CORRECTION

In last month's Audio Report, the price of the University Tri-Planar speaker system was quoted incorrectly. It should have been $79.95.

Regardless Of What You Pay For Other Color TV

It Can't Perform As Well As This One...



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Exclusive Heath Features For Unequalled Performance! That's right. No matter how many of your hard-earned dollars you pay for another brand of color TV, *none* can equal the performance of the Heathkit All-Channel, High Fidelity 21" Color TV! Why? *All* color sets require minor periodic adjustments to maintain peak picture performance. The Heathkit GR-53A is the *only* set with a "built-in service center" that provides the facilities for perfect picture adjustments. Heath's simple-to-follow instructions & detailed color photos show you exactly what to look for and how to achieve it . . . quickly, easily! You become the expert! Result? Beautiful, true-to-life color pictures day in and day out . . . and *no* costly color TV service calls for simple picture alignment!

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Finest Components, Most-Advanced Circuitry

With the Heathkit GR-53A you're assured of the finest parts and most advanced color TV circuitry that money can buy . . . at up to $200 savings. You enjoy rock-steady pictures with no overlap or color fringing.

But Don't Take Our Word For It!

See the special articles on the Heathkit GR-53A in the May issue of *Popular Electronics*, June issue of *Radio-TV Experimenter*, February issue of *Popular Mechanics*, April issue of *Science & Mechanics*, and the August issue of *Radio-Electronics!*

Now Compare The Features . . . . And The Price!

In addition to the ones already mentioned, there's the high definition 70° 21" color tube with anti-glare bonded safety glass; 24,000 volt regulated picture power; 27 tube, 8 diode circuit; deluxe Standard-Kollsman VHF tuner with push-to-tune fine tuning for individual channels and transistorized UHF tuner for all-channel (2-83) reception; automatic color control and gated AGC for peak performance; line thermistor for longer tube life; two hi-fi outputs plus tone control; transformer operation; chassis & tube mounting on sturdy one-piece metal support for easy set-up and servicing; plus a low price of only $399.

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New Semiconductors and Tubes

LOW-PRICE SILICON PLANAR LINE

A wide line of mass-produced silicon planar transistors aimed at "consumer" applications as well as industrial uses has been announced by General Electric. The devices have the features common to most silicon devices: wide operating temperature range, low leakage and long life.

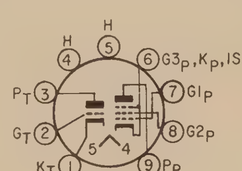
One type, the 2N2926, is priced at 22 cents each in quantities of 100,000—a bit more than you'll need at first, but that means that silicon transistors, till now limited mostly to high-priced industrial and military stuff, may begin appearing in radios, hi-fi's, TV sets and so forth.

The cases of these transistors are epoxy, 0.185 inch in diameter and 0.260 inch high.

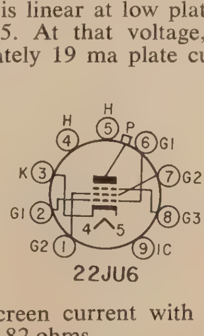
Ratings vary widely with intended use, but the general-purpose types have an h_{fe} (small-signal current gain) of 75 to 180 *minimum* at 1 kc, collector-to-emitter breakdown ratings of up to 50 volts, and a gain-bandwidth product (typical) of 160.

11LQ8, 22JU6

These two new tubes are designed to meet the demands of television. The 11LQ8 is a 9-pin miniature tube containing a medium-mu triode ($\mu = 46$) and a high-transconductance, sharp-cutoff pentode ($g_m = 21{,}000$ μmhos). The triode may be used in general-purpose voltage amplification, as sync separator or sound i.f. amplifier. The pentode is suited as a video output stage. It has a controlled plate-current "knee" so that it is linear at low plate voltages—like 125. At that voltage, it draws approximately 19 ma plate current and 3.8 ma screen current with a cathode resistor of 82 ohms.



IILQ8



22JU6

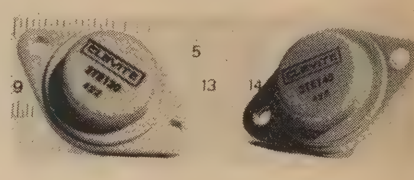
The 22JU6 is a horizontal output tube with a novar base and a 22-volt 0.45-amp heater. It, too, is designed to operate at remarkably low B-plus voltages—around 140. Plate dissipation is 17 watts maximum; average cathode current, 275 ma maximum; transconductance, 7,000 μmhos. The plate is designed especially to minimize secondary emission, and the tube as a whole is made to respond to low grid 1 driving voltages.

Grid 3 is brought out to a separate base pin so that a positive voltage can be applied to it to minimize "snivets".

HF SILICON POWER TRANSISTORS

Progress in high-frequency, high-power, high-gain transistors continues. The limitation now is not so much frequency or power (plenty of transistors can deliver several watts at 50 or 100 mc or more), but gain. The silicon structures for those frequencies always seem to end up with little power gain—often as little as 4 to 6 db (2½ to 4 times).

A new line from Clevite Semiconductor, the 3TE100 series, has reasonable gain with considerable power. The 3TE120, the highest-power device in the line, in a "diamond" TO-3 case, can put out more than 50 watts of rf at 70 mc, with 8 db gain, at a supply voltage of 28. Key to the new design is the *emitter*-to-case connection (instead of collector to case, as usual). This reduces input and feedback capacitances, according to the manufacturer.



Other units in the line show decreasing output powers and increasing gains. The 3TE160, at the other end, delivers 0.6 watt with 14.7 db gain at 70 mc, 40 volts supply.

The one factor we didn't juggle above is price: still to be reckoned with. The smallest of the lot, the 3TE160, costs $12. The biggest, the 3TE120, with its low gain and all, costs $185.

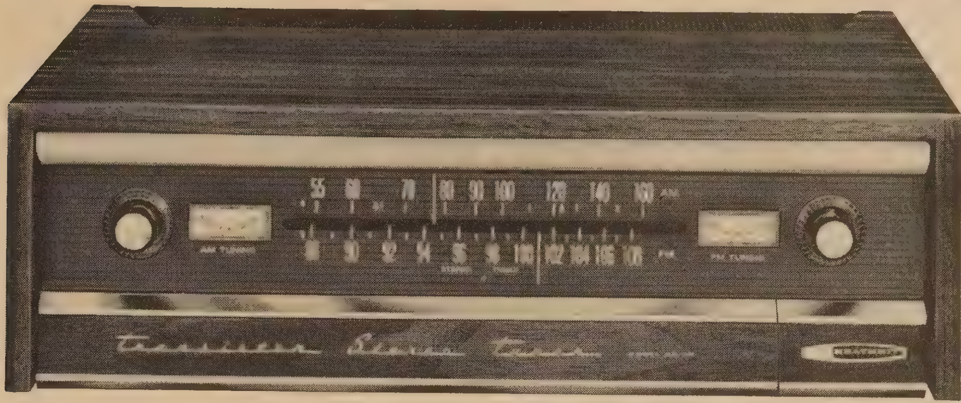
3-AMP LEAD-MOUNT RECTIFIERS

A new MR1030 series of silicon rectifiers just announced by Motorola offers a 3-amp continuous forward rectified current rating in a lead-mounting (not stud-mounting) package. Pretty good, hey? You have your choice, too, of whether you want a lead out each end or both leads out the same end (axial or single-ended, respectively), and whether you want normal polarity (cathode to case) or reverse polarity (anode to case, denoted by an "-R" after the type number).

These units should be especially interesting to all who want to build medium-to-high-current transistor power supplies, battery chargers, etc., but balk at the mounting problems for stud-

continued on page 80

For The Stereophile With An Eye...



As Appreciative As His Ear...

New Heathkit® Deluxe Transistor Stereo!

Luxurious New Walnut Cabinet Styling!

Do you consider appearance as carefully as performance when choosing stereo components? If you do, then you'll delight in the *new look* of Heathkit Deluxe Transistor Stereo! Sleek, richly warm walnut cabinets. Clean, uncluttered charcoal gray upper front panels. Soft, refracted panel lighting. Hinged, lower front walnut panels to neatly conceal all secondary controls and avoid accidental system setting changes. Beautiful enough to capture the spotlight in any room!

And The Sound?

As modern and beautiful as the new styling. Transistor sound with its broad, clean, unmodified response ... no compromising! Add cool, instant operation, simplicity of assembly and the low Heath prices ... and you have the best value in transistor stereo today — bar none!

Under These Beautiful Cabinets ...

you'll find the most advanced solid-state circuitry. The magnificient Heathkit AJ-43 Stereo Tuner features 25 transistors and 9 diodes ... wide-band AM, FM & FM Stereo to satisfy any listening wish ... *automatic* switching to stereo plus an automatic stereo indicator light that signals when stereo is received ... filtered left & right channel outputs for direct, beat-free stereo recording ... separate AM & FM tuning meters ... automatic frequency control to lock in desired station for rock-steady, drift-free reception ... automatic gain control that eliminates "blasting" or "fading" of incoming signals, keeps volume constant ... adjustable FM squelch to let you tune across the dial *without* annoying between-station noise ... stereo phase control for maximum separation, minimum distortion ... and a factory-built & aligned FM "front-end" tuner and 5-stage FM I.F. circuit board for quick, easy assembly!

Matching Heathkit AA-21 Stereo Amplifier!

This superb unit boasts a 26 transistor, 10 diode circuit that produces 70 watts continuous, 100 watts IHF music power at $\pm$ 1 db from 13 to 25,000 cps. And you enjoy complete freedom from microphonics, effortless transient response, and cool instant operation ... characteristics unobtainable in tube-types.

In addition, there are complete controls, plus all inputs and outputs to handle any program source & most speaker impedances. Circuit safety is assured with 5 fast-acting, bi-metal circuit breakers ... no fuses to replace ever! Transformerless output circuit and multiple feedback loops provide fine fidelity and low distortion levels.

With its encapsulated, epoxy-covered circuit modules and five stable circuit boards, the AA-21's assembly is fast, simple and fun ... requires *no* special skills or knowledge!

Please Your Ear, Your Eye & Your Sense Of Value!

Choose this matched Heathkit Transistor Stereo pair now for better performance and appearance at lower cost!

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Kit AA-21C, amplifier, 29 lbs..........$149.95

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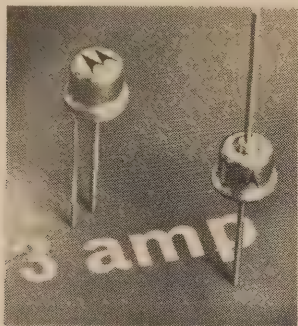
CARD REMOVED

continued from page 74
mount rectifiers in a bridge circuit.

The 3-amp current rating is at an ambient temperature of 75°C, by the way—about the temperature of really hot household tap water. The units are available in peak-inverse-voltage ratings



from 50 to 600 volts, numbered MR1030, -1031, etc., to -1036. Half-cycle surge rating is 300 amps.

The high heat-dissipation capability is a result of "increased semiconductor junction area combined with a slight increase in lead diameter." Prices start at about $0.55 for the 50-volt rectifier (quantity 1–99 pieces). All units are about ⅜ inch in diameter by about ⅜ inch high.

DTG 1000, 2000, HI-POWER GERMANIUMS

Two new series of germanium high-

power transistors with current ratings of 15 and 25 amperes, respectively, are available from the Delco Radio Div. of General Motors Corp. Selected units have collector-to-emitter voltage ratings as high as 325—rather unusual for germanium transistors. The DTG 1000 series is intended for auto ignition and for TV horizontal and vertical deflection output stages, or wherever a high peak power needs to be switched.

All members of the series are in the TO-3 diamond-shaped package.

AFC VARIABLE-CAP DIODES

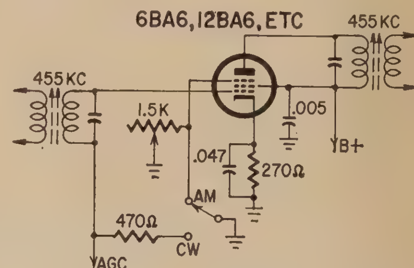
A new voltage-variable-capacitance diode, designed specifically for afc and tuning in home-entertainment FM sets, has been announced by Texas Instruments, Inc. The principal attraction of the new device, called the A660, is its Q of 230 at 50 mc, compared to average Q's of 20 for similar competitively priced diodes.

Another feature is the close production tolerances maintained for the diode. Both Q and capacitance values are claimed to "track" very well from one diode to another, which is expected to simplify mass production of FM front ends, for example.

The A660 diode is relatively inexpensive compared to previous variable-capacitance diodes—$1.25 in quantities from 1 to 99 to original-equipment manufacturers. Additional information is available from Semiconductor Components Div., Texas Instruments, Inc., 13500 North Central Expressway, Dallas, Tex. END

Q-Multiplier Sharpens Code Reception

WHEN LISTENING TO CW SIGNALS, YOU can use much higher selectivity than on AM. Indeed, this is one of the advantages of code over phone. An i.f. amplifier can be modified very easily to add selectivity and gain, making it more useful for CW reception. Instead of grounding the suppressor, a variable resistor is connected in series, to cause regeneration.



For the sharpest tuning, the 1,500-ohm resistor is adjusted slightly below the point of oscillation with the switch in CW position. The switch also shorts out the agc (or avc) to receive code. When switched to AM, the suppressor is grounded and agc restored.

Increasing the resistance further results in oscillation. Then the circuit becomes a bfo, as well as an i.f. amplifier.

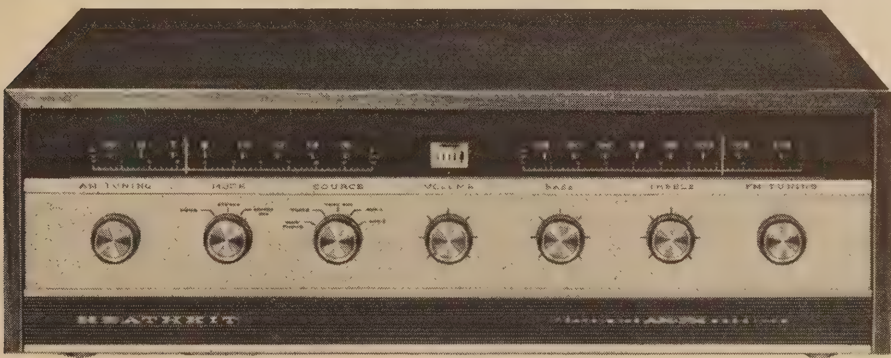
This circuit is disclosed in patent 3,107,333, issued to Robert J. Orwin and assigned to Hallicrafters Co.—*I. Queen*

"Where's the illiterate who spells 6BR8 with a single cathode?"

Which Stereo Receiver Is Your Best Value?

BRAND	IHF POWER	TUNER	CIRCUIT	PRICE
A	70 Watts	AM-FM FM Stereo	Transistor	$369.95
B	80 Watts	AM-FM FM Stereo	Tubes	$374.50
C	100 Watts	AM-FM FM Stereo	Transistor	$619.95
D	70 Watts	FM Stereo	Tubes	$429.90
E	66 Watts	AM-FM FM Stereo	Transistor	$195.00
F	60 Watts	FM Stereo	Tubes	$354.45
G	60 Watts	AM-FM FM Stereo	Tubes	$273.90
H	100 Watts	AM-FM FM Stereo	Transistor	$579.90
I	70 Watts	AM-FM FM Stereo	Tubes	$269.95

IF YOU CHOOSE E GO DIRECT TO THE COUPON & COLLECT $75 TO $425 SAVINGS!



"E" is the Heathkit AR-13A All-Transistor, All-Mode Stereo Receiver. It's the first all-transistor stereo receiver kit. It costs from $75 to $425 less than the finest stereo receivers on the market today. This alone makes the AR-13 unique. But dollar savings are only one reason why it's your best value.

Even if you can afford to buy the costliest model, you can't buy better performance. Start with the AR-13A's 43-transistor, 18-diode circuit. It's your assurance of cool, instant, "hum-free" operation; long, trouble-free life; and the quick, clean, unmodified response of "transistor sound" . . . characteristics unobtainable in tube types.

Next, there's wide-band AM, FM, FM Stereo tuning for distortion-free reception to delight the most critical ear. It has two preamps. And its two power amplifiers provide 66 watts of IHF Music Power, 40 watts of continuous sine-wave power. And it's all housed inside one luxurious, compact walnut cabinet . . . just add two speakers for a complete stereo system.

There are plenty of operating conveniences, too. Like *automatic* switching to stereo; automatic stereo indicator; filtered tape recorder outputs for direct "beat-free" stereo recording; dual-tandem controls for simultaneous adjustment of volume, bass, and treble of both channels; 3 stereo inputs; and a separate control for balancing both channels. The AM tuner features a high-gain RF stage and a high Q rod antenna. The FM tuner has a built-in line cord antenna plus external antenna connectors.

In addition, there's a local-distance switch to prevent overloading in strong signal areas; a squelch control; AFC for drift-free reception; plus flywheel tuning, tuning meter, and lighted AM & FM slide-rule dials for fast, easy station selection. The secondary controls are concealed under the hinged lower front gold aluminum panel to prevent accidental system setting changes. Both of the AM and FM "front-ends" and the AM-FM I.F. strip are pre-assembled and prealigned to simplify construction.

Compare its impressive specifications. Then go direct to the coupon, and order the AR-13A. Now sit back and relax . . . you've just saved $75 to $425 without compromising!

Kit AR-13A, 34 lbs..............$195.00

SPECIFICATIONS—AMPLIFIER: Power output per channel (Heath Rating): 20 watts /8 ohm load. (IHFM Music Power Output): 33 watts /8 ohm load. **Power response:** ±1 db from 15 cps to 30 kc @ rated output. **Harmonic distortion:** (at rated output) Less than 1% @ 20 cps; less than 0.3% @ 1 kc; less than 1% @ 20 kc. **Intermodulation distortion:** (at rated output) Less than 1%, 60 & 6,000 cps signal mixed 4:1. **Hum & noise:** Mag. phono, 50 db below rated output; Aux. inputs, 65 db below rated output. **Channel separation:** 40 db. **Input sensitivity:** Mag. phono, 6 MV. **Outputs:** 4, 8, & 16 ohm and low impedance tape recorder outputs. **Controls:** 5-position Selector; 3-position Mode; Dual Tandem Volume; Bass & Treble Controls; Balance Control; Phase Switch; Input Level Controls; Push-Pull ON /OFF Switch. **FM: Tuning range:** 88 mc to 108 mc. **IF frequency:** 10.7 mc. **Frequency response:** ±3 db, 20 to 15,000 cps. **Capture ratio:** 10 db. **Antenna:** 300 ohm balanced (internal for local reception). **Quieting sensitivity:** 3½ uv for 30 db of quieting. **Image rejection:** 30 db. **IF rejection:** 70 db. **Harmonic distortion:** Less than 1%. **STEREO MULTIPLEX: Channel separation:** (SCA Filter Off) 30 db, 50 to 2,000 cps. **19 KC & 38 KC suppression:** 45 db down. **SCA rejection:** 35 db down from rated output. **AM: Tuning range:** 535 to 1620 kc. **IF frequency:** 455 kc. **Sensitivity:** 30 uv @ 600 kc; 9 uv @ 1000 kc. **Image rejection:** 40 db. **IF rejection:** 55 db @ 1000 cps. **Harmonic distortion:** Less than 2% with 1000 uv input, 400 cps with 30% modulation. **Hum and noise:** 40 db. **Overall dimensions:** 17" L x 5½" H x 14¾" D.

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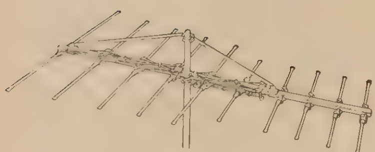
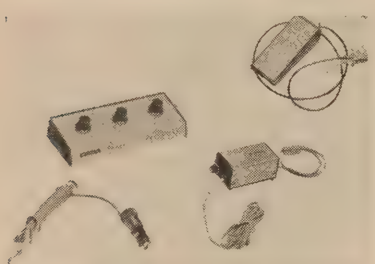
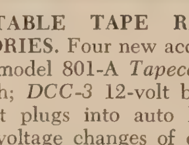


LOG PERIODIC FM STEREO ANTENNA, *LPL-FM10*, provides 4.1 db more gain than 10-element FM yagi. The array of L-shape log periodic dipoles is of back-fire, front-fed type with front-to-back ratios up to 26 db. The L-dipoles employ transmission-line transformers and 180° phased feeder harness to insure precise 300-ohm impedance. Narrow beamwidths and minor lobe levels reject reflected signals. Dipoles are ½-in. aluminum tubing, and entire antenna is gold alodized. Factory preassembled.—**JFD Electronics Corp.**, 15 Ave. & 62 St., Brooklyn 19, N. Y.



PORTABLE TAPE RECORDER ACCESSORIES. Four new accessories for the Sony model 801-A *Tapecorder: FS-4* foot switch; *DCC-3* 12-volt battery converter that plugs into auto lighter and stabilizes voltage changes of car battery; *AC-91* ac converter for 117-volt 60-cycle ac; *MX-10K* microphone mixer with three line and mike inputs. Also available *TP-4S* telephone pickup for recording telephone conversations.—**Superscope Inc.**, 8150 Vineland Ave., Sun Valley, Calif.



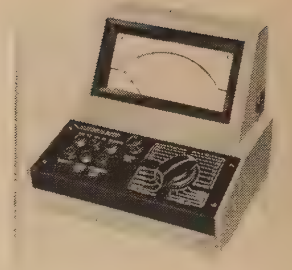
CERAMIC MICROPHONE HEARING AID, *model 300*, uses low-impedance ceramic microphone which does not pick up magnetic hum and is not affected by temperature and humidity. Has separate off-on switch, volume control and control for switching to automtaic volume control, telephone pickup or microphone. Five separate tone and level controls compensate for a wide range of hearing losses.—**Sonotone Corp**, Elmsford, N. Y.

CONNECTOR PIN CONTAINS FUSE, addition to *Picofuse* line. Has one end of a tiny *Picofuse* terminated in a pin that is part of a multi-pin connector and was developed for aerospace computer, communications, instruments and other subminiature applications. Factory-installed in any diameter male pin having a large enough barrel to accept the .078-in. diameter fuse. Ratings from ⅛ to 5 amps at 125 volts, with short-circuit interrupting capacity of 300 amps at 130 vdc.—**Littelfuse, Inc.**, 800 E. Northwest Highway, Des Plaines, Ill.

SPEAKER, model *AR-4*, in oiled walnut enclosure or unfinished pine. 19 x 10 x 9 in. Acoustic suspension with 8-inch woofer and 3½-in. wide-dispersion tweeter.—**Acoustic Research, Inc.**, 24 Thorndike St., Cambridge, Mass. 02141

SQUARE-WAVE GENERATOR, *Squaremaker, ME-109*, converts an audio or video oscillator into a high-quality square-wave generator. No batteries or power connections are required; the transistors are powered direct from the input sine wave. Frequency and amplitude are adjustable over a wide range by oscillator controls. Typical performance data: 50 nanoseconds rise time; up to 35 volts output; useful as a trigger for 1 cycle to 1 megacycle; square-wave frequency range of 15 cycles to 500 kc.—**Monterey Electronic Products**, 651 Cannery Row, Monterey, Calif.

PORTABLE VOM, *model 80*, packaged in console-type case, features a tilted meter face and refractive anti-parallax scale. Reads ac and dc volts, direct current and ohms; has 1% dc and 1½% ac accuracy. Output meter scale. Dc voltage



ranges at 20,000 ohms per volt: 0.25, 1, 2.5, 10, 25, 50, 100, 250, 1K, 5K. Ac voltage ranges at 5,000 ohms per volt: 2.5, 10, 50, 250, 500, 1,000 and 5,000. Direct current ranges: 50 microamperes, 1, 10 and 100 ma, 1 and 10 amperes. Case of shock-resistant resin, with self-storing leads which fit under a clip at the back.—**Weston Instruments, Inc.**, 614 Frelinghuysen Ave., Newark 14, N. J.

UHF ANTENNA, the *Tracker*, uses incident-wave principle with tangent paraboloid reflector system. Frequency response across all channels (14 to 83) with measured gain of ±13 db. Impedance match into 300 ohms is 1.5:1 or better at all uhf frequencies. 4 feet high, of anodized aluminum with snaplock hardware.—**Winegard Co.**, Burlington, Iowa.

PRERECORDED STEREO TAPES, a new series for operation at 3¾ inches per second, providing 2 hours of continuous music at prices directly competitive with phonograph records. Average frequency response of ±3 db, 40 cycles to 12 kc, signal-to-noise ratio 48 db and flutter of 0.12%. Tapes are manufactured with automatic reverse signal so they reverse themselves and play both sides without handling when played back on Ampex 2000 line recorders.—**Ampex Corp.**, 401 Broadway, Redwood City, Calif.

23-CHANNEL CB TRANSCEIVER, the *HB-400*, crystal-controlled with receiver tuning variable ±2.5 kc. Dual-conversion receiver has 0.3-μv sensitivity and plug-in facilities for *model HA-200* selective call unit. Built-in 117-vac/12-vdc power supply. Ceramic push-to-talk mike. 12 x 5 x 10 in.—**Lafayette Radio Electronics Corp.**, 111 Jericho Turnpike, Syosset, N. Y.

AC/DC TRANSCEIVER, *model CB-9*, has 6 crystal-controlled channels plus full-channel receiver tuning with spotting

SB-200 KW Linear Amplifier............$200!
• 1200 watts P.E.P. input SSB—1000 watts CW • 80 through 10 meter band coverage • Built-in SWR meter—Antenna relay—Solid-state power supply • Automatic Level Control (ALC) • Sheilded, fan-cooled amplifier compartment • Pre-tuned cathode input circuit for maximum efficiency & low distortion • Circuit-breaker power supply protection—no fuses • Designed for 120/240 volt operation.

Neat, compact and transportable (only 35 lbs.). The sturdy, yet lightweight construction of the SB-200 is achieved through the use of a heavy-gauge one-piece aluminum chassis that is partitioned for extra strength and isolation of circuits. Easy assembly is assured with clean, open circuit layout and high quality, well-rated components. The modern low-profile styling of the SB-200 makes it a neat, compact desk-top linear that is ideal for use anywhere!

Kit SB-200, 42 lbs....................$200.00
Note: Unit suitable for overseas operation.

SB-200 SPECIFICATIONS—Band coverage: 80, 40, 20, 15 & 10 meters. **Maximum power input:** 1200 watts P.E.P. SSB, 1000 watts CW. **Driving power required:** 100 watts. **Duty cycle:** SSB, continuous voice modulation; CW, 50% (key down time not to exceed 5 min.). **Third order distortion:** 30 db or better at 1000 watts P.E.P. **Output impedance:** 50 to 75 ohm unbalanced; variable pi-output circuit. SWR not to exceed 2:1. **Input impedance:** 52 ohm unbalanced; broad-band pre-tuned input circuit requires no tuning. **Meter functions:** 0-100 ma grid current, 0-1000 ma plate current, 0-1000 relative power, 1:1 to 3:1 SWR, 1500 to 3000 volts high voltage. **Front panel controls:** Load; Tune; Band; Relative Power Sensitivity; Meter Switch, Grid-Plate-Rel. Power-SWR-HV; and Power Switch, on/off. **Tube complement:** Two 572B/T-160-L (in parallel). **Power requirements:** 120 volts AC @ 16 amperes (max.), 240 volts AC @ 8 amperes (max.) **Cabinet size:** 14⅞" W x 6⅝" H x 13⅜" D. **Net weight:** 35 lbs.

SB-300 SSB Receiver.................$265!
• Complete coverage of 80 through 10 meter amateur bands • All crystals included, plus provision for VHF converters • Hermetically sealed 2.1 kc crystal bandpass filter • Built-in 100 kc crystal calibrator • Smooth, non-backlash venier dial mechanism • 100 cps stability after initial warmup • 1 kc dial calibrations—100 kc per dial revolution (provides bandspread equal to 10 feet per megacycle) • Provision for transceive operation with SB-400 Transmitter • Prebuilt linear master oscillator (LMO), wiring harness and two heavy-duty circuit boards for fast, easy assembly.

Kit SB-300, less speaker...22 lbs......$265.00
SBA-300-1 Optional AM Crystal Filter (3.75 kc) 1 lb...............................$19.95
SBA-300-2 Optional CW Crystal Filter (400 cps) 1 lb...............................$19.95
SBA-300-3 (6 meter converter), 2 lbs.....$19.95
SBA-300-4 (2 meter converter), 2 lbs.....$19.95
Export model available for 115/230 VAC, 50-60 cps; write for prices.

SB-300 SPECIFICATIONS—Frequency range (megacycles): 3.5 to 4.0, 7.0 to 7.5, 14.0 to 14.5, 21.0 to 21.5, 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30. **Intermediate frequency:** 3.395 megacycles. **Frequency stability:** 100 cps after warm-up. **Visual dial accuracy:** Within 200 cps on all bands. **Electrical dial accuracy:** Within 400 cps on all bands. **Backlash:** No more than 50 cps. **Sensitivity:** Less than 1 microvolt for 15 db signal plus noise-to-noise ratio for SSB operation. **Modes of operation:** Switch selected: LSB, USB, CW, AM. **Selectivity:** SSB: 2.1 kc at 6 db down, 5.0 kc at 60 db down (crystal filter supplied). AM: 3.75 kc at 6 db down, 10 kc at 60 db down (crystal filter available as accessory). CW: 400 cps at 6 db down, 2.5 kc at 60 db down (crystal filter available as accessory). **Spurious response:** Image and IF rejection better than 50 db. Internal spurious signals below equivalent antenna input of 1 microvolt. **Power requirements:** 120 volts AC, 50/60 cps, 50 watts. **Dimensions:** 14⅞"W x 6⅝"H x 13⅜"D.

SB-400 SSB Transmitter...............$325!
• Built-in power supply • Complete transceive capability with SB-300 Receiver • Linear Master Oscillator frequency control • Built-in antenna change-over relay • All crystals supplied for complete 80-10 meter coverage • Automatic lever control for higher talk power, minimum distortion • 180 watts PEP SSB, 170 watts CW • Crystal filter type SSB generation • Operates SSB (upper or lower sideband) & CW • VOX & PTT control in SSB operation, VOX operated CW break-in • Crystal controlled heterodyne oscillators • 1 kc dial calibration—100 kc per dial revolution • Dial bandspread equal to 10 feet per megacycle • 500 kc coverage per band-switch position • Switched 120 V AC for external antenna relay • Sturdy, lightweight, heavy-gauge aluminum construction throughout • Neat, modern "Low-Boy" styling! • Variable loading!

Kit SB-400, 33 lbs......................$325.00
Export model available for 115/230 VAC, 50-60 cps; write for prices.

SB-400 SPECIFICATIONS—Emission: SSB (upper or lower sideband) and CW. **Power Input:** 170 watts CW, 180 watts P.E.P. SSB. **Power output:** 100 watts (80-15 meters), 80 watts (10 meters). **Output impedance:** 50 to 75 ohm—less than 2:1 SWR. **Frequency range:** (mc) 3.5-4.0; 7.0-7.5; 14.0-14.5; 21.0-21.5; 28.0-28.5;28.5-29.0; 29.0-29.5; 29.5-30.0. **Frequency stability:** Less than 100 cps per hr. after 20 min. warmup. **Carrier suppression:** 50 db below peak output. **Unwanted sideband suppression:** 55 db @ 1 kc. **Intermodulation distortion:** 30 db below peak output (two-tone test). **Keying characteristics:** Break-in CW provided by operating VOX from a keyed tone (Grid block keying). **ALC characteristics:** 10 db nominal @ 0.2 ma final grid current. **Noise level:** 40 db down from single tone output. **Visual dial accuracy:** Within 200 cps (all bands). **Electrical dial accuracy:** Within 400 cps (all bands). **Audio input:** High impedance microphone or phone patch. **Audio frequency response:** 350 to 2450 CW at 6 db. **Power requirements:** 80 watts STBY, 260 watts key down @ 120 V AC line. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

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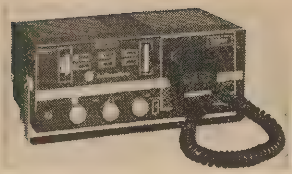
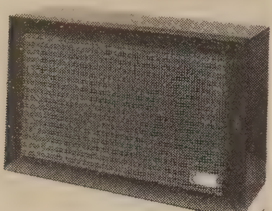
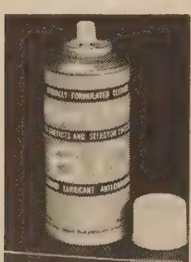


switch and S-meter. All-electronic push-to-talk circuitry. 100% modulation and receiver sensitivity of 1 μv for 10-db signal-to-noise ratio claimed. Output 3.2 watts. Drop-down chassis feature. 14 lb, 12 x 7 x 5 in. Ready to operate either base or mobile.—**Hallicrafters Co.,** 100 E. Ohio St., Chicago, Ill. 60611



MINIATURIZED HI-FI SPEAKER SYSTEM, *Mini-Flex II.* Frequency response of 45 to 18,000 cycles. 6½-in. woofer with 3½-in. mid-range cone, separate tweeter and crossovers at 800 and 2,000 cycles. 15 x 9½ x 6 in.—**LTV University,** 9500 W. Reno, Oklahoma City, Okla.

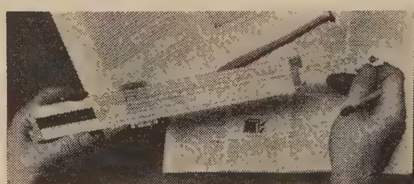


SPRAY CLEANER, *Kontact 60.* For contacts, switches and components. Leaves lubricant film, protects parts from corrosion, is non-conductive. Injector tubing for hard-to-reach areas. 6 oz.—**Jonard Industries Corp.,** 3733 Riverdale Ave., Bronz 63, N.Y.

TRANSISTOR CAPACITANCE RESISTANCE BRIDGE, *model 62.* Uses 9-volt transistor battery, checks capacitors in range of 1 pf to 100 μf, resistors in range of 100 ohms to 100 megohms. Controls: range, power factor %, bridge tuning (C and R), test jacks. 6⅝ x 4⅝ x 2⅝ in., less than 2 lb.—**Path Products Corp.,** 55 Halley St., Yonkers, N.Y.

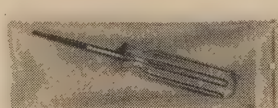
TAPE-HEAD CLEANER. *No-Noise Tape-Reco Head Cleaner* dissolves oxide and lubricant deposits resulting from recorder operation. Contains no carbon tet, won't affect plastics, is nonflammable and nontoxic. Applied with 5-inch plastic extender push-button assembly.—**Electronic Chemical Corp.,** 813 Communipaw Ave., Jersey City 4, N. J.

SLIDE RULE for electronic engineers and technicians has scales for solving reactance and resonance-frequency problems. Locates decimal points and provides widely used formulas and conversion



factors not found on other scales. Included is 123-page manual with several hundred practice problems.—**Cleveland Institute of Electronics,** 1776 E. 17 St., Dept. 100, Cleveland, Ohio 44114

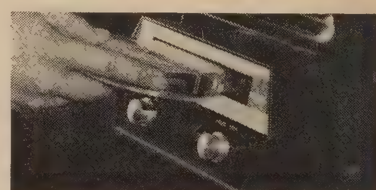
ALL-WEATHER VINYL ELECTRICAL TAPE, *No. 104,* has dielectric strength of 10,000 volts and insulation resistance of more than 100,000 megohms. .0085 in. thick, will elongate 200% before breaking; ultimate tensile strength 22 lb per in. of width; peel strength 20 oz per in. of width. Plastic container with built-in cutter.—**International Resistance Co.,** 414 N. 13 St., Philadelphia, Pa. 19108



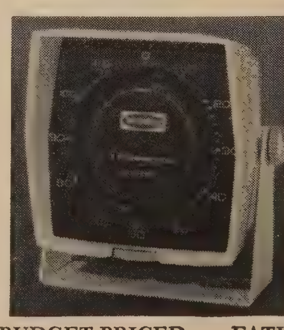
TAPPING TOOL, the *3-in-1,* taps holes to 10-32, 8-32 or 6-32 thread all on one hardened tool-steel blade. Has shockproof, breakproof and nonabsorbent handle.—**Vaco Products Co.,** 317 E. Ontario St., Chicago, Ill. 60611

PENCIL DE-SOLDERING/RE-SOLDERING IRON, Endeco *model 300,* for removing and replacing minature components in printed-circuit boards and conventional wiring is 8 in. long and weight 3½ oz. Rated 40 watts at 115 volts and delivers a 720°F tip temperature. Tips are available in 5 sizes; the .080-in. is standard.—**Enterprise Development Corp.,** PO Box 55144, 1102 E. 52 St., Indianapolis, Ind. 46205

SEALED LEAD-ACID BATTERIES, *MF-1, MF-2,* for portable power devices, can be built into tools and appliances or carried by shoulder strap or belt hook. 5- and 7½-lb sizes never require addition of water or acid, hydrometer readings or cleaning of metallic cell connectors. *MF-1* (6-volt) produces 1.1 amperes at 8-hr rate, 1.35 (6-hr), 2.3 (3-hr), 5.3 (1-hr), 8.2 (½-hr), 16.5 (5-min). *MF-2* (12-volt) produces 0.8 amps (8-hr), 1 (6-hr), 1.7 (3-hr), 3.6 (1-hr), 5.4 (½-hr), 10.2 (5-min).— **Exide Industrial Marketing Div., ESB Co.,** Rising Sun and Adams Aves., Philadelphia, Pa. 19120

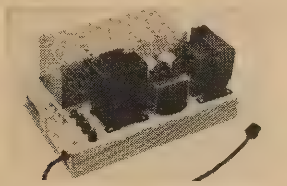


TAPE PLAYER FOR CARS. *Auto-*Mate, designed to accept a sealed plastic cartridge with a continuous 2-track magnetic tape, has universal bracket and can be used in cars, trucks or boats equipped with AM radios in the 800–1,000-kc range. Has its own transistorized amplifier–oscillator circuit, feeds oscillator output at about 900 kc through antenna circuit of the radio.— **J. Herbert Orr Enterprises, Inc.,** Opelika, Ala.

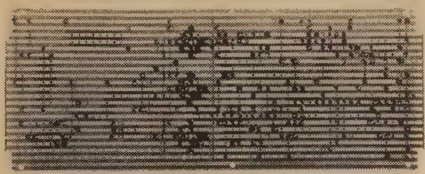


BUDGET-PRICED FATHOMETERS. The *DE-720A* has a 60-foot scale

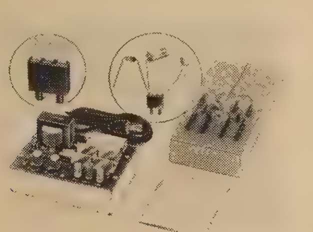
and the *DE-722* is scaled to 120 feet. Both use magnetic keying and transistors and draw only 12/100 amp. Can be supplied with any of 3 optional transducers.—**Raytheon Co.,** Lexington, Mass. 02173



LOW-HIGH BAND-EXTENDER AMPLIFIER, *model LHE 501 R,* handles low- and high-band TV and FM signals. Has 2 output terminals: one to extend feeder lines; the second (—20 db) to split the line or feed a distribution amplifier. Low- and high-band gain and tilt controls, flat frequency response, long-life silicon rectifiers, 10,000-hour tubes.—**Entron, Inc.,** 2141 Industrial Parkway, Silver Spring, Md.

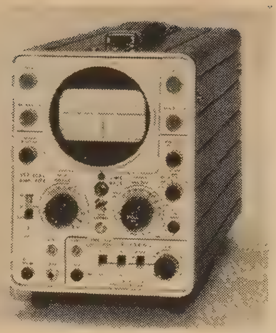


PROTOTYPE CIRCUIT BOARD, *Veroboard,* 1.55-mm-thick synthetic resin-bonded paper laminate, to which are bonded a number of strips of copper .38 mm thick, pierced with matrix of holes and protected with flux preservative. Copper strips carry 1 amp with only 1°C rise above ambient; 5 amps with 39°C rise. Resistance .045 ohm per inch. Comes in 18-inch lengths, fully pierced, double-sided, plug-in type or plain.—**Vero Electronics Inc.,** 48 Allen Blvd., Farmingdale, N.Y.



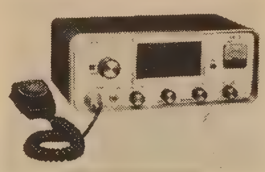
SOLDERLESS BREADBOARD CIRCUIT KIT, *model BB-1,* has 2 types of plug-in connectors, perforated chassis and optional dc power supply. Kit includes 40 *T-3* connectors with 3 electrically connected lugs for plugging in a number of components, and 10 *T3S* connectors, with 3 electrically isolated lugs for accepting individual component leads. Optional with kit is model *PS-100* dual-voltage, transistor-regulated dc power supply.—**Buckeye Stamping Co., Electronics Div.,** 555 Marion Rd., Columbus, Ohio 43207

PORTABLE SCOPE, *type 321A,* is 5¾ x 8¼ x 16 in. and weighs 18 lb. Oper-



ates from 4 to 4½ hr. on internal rechargeable batteries from any dc source of 11.5 to 35 volts, or from any ac source of 50 to 800 cycles. Passband is dc to 6 mc, maximum calibrated sensitivity is 10 mv/¼ in. div. Wide-range time base provides calibrated sweep speeds to 0.5 μsec per division; a ×5 magnifier extends this sweep to 0.1 μsec/div.—**Tektronix, Inc.,** PO Box 500, Beaverton, Ore. 97005

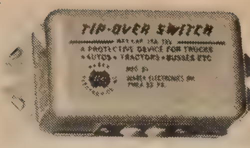
23-CHANNEL AM TRANSCEIVER, *model CAM-88 Cobra,* has integral crystal synthesizer. Double-conversion superhet receiver has 2 stages of i.f. amplification. Meter on front panel measures incoming signal strength on receive and



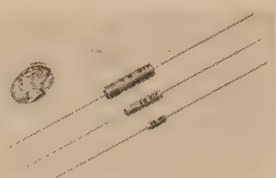
relative power output on transmit. Audio volume control for both CB reception and public address. Auxiliary speaker plug at rear. Transistorized universal ac/dc power supply operates on both 117 vac and 12 vdc. Mounting bracket for car installation. Earphone jack on front panel.—**B&K/Mark, Div. of Dynascan Corp.** 1801 W. Belle Plaine Ave., Chicago, Ill.

ELLIPTICAL STYLUS CARTRIDGE, *880PE.* Frequency response: 8 to 30,000 cycles; 8.0 mv per channel output voltage; channel separation more than 30 db; load impedance 47,000 ohms; weighs 10 grams; 20×10^{-6} cm/dyne compliance; ½ to 4 grams tracking force; .2 x .9-mil bi-radial elliptical hand-pol-

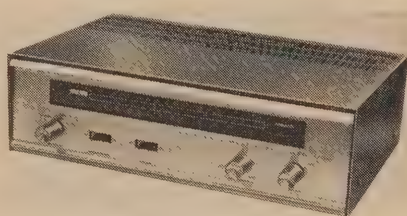
ished diamond stylus; 4 terminal output; standard 7/16-or ½-inch mounting centers. Elliptical stylus for the *880PE* is available as a replacement for the ones on the *880* and *880P.*—**Empire Scientific Corp.,** 845 Stewart Ave., Garden City, N. Y.



PROTECTIVE TIPOVER SWITCH automatically shuts off ignition of any motor vehicle when it overturns. A mercury switch, it could be used in many applications as a position-oriented switch with its automatic on–off feature when tilted past 45°.—**Waber Electronics, Inc.,** Hancock & Somerset Sts., Philadelphia, Pa. 19133

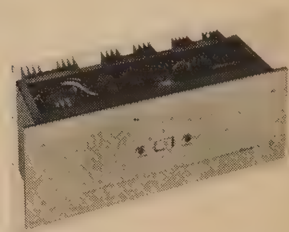


MINATURE TANTALUM CAPACITORS, *MTP,* in 15 standard ratings, were developed for Minuteman II program. Operating temperatures from −55° to +85°C, all values polarized. Standard tolerance ±20%. Ratings range from 4 μf at 50 wvdc to 450 μf at 6 wvdc. Four case sizes from 0.115-in. diameter x 0.312-in. long up to 0.225-in. diameter x 0.764-in. long.—**Mallory Distributor Products Co.,** Indianapolis, Ind. 46206



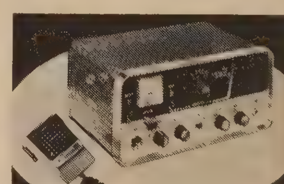
AM/FM STEREO TUNER, *LT-325,* produces an audible signal in both channels when a stereo station is tuned in. Tuner sensitivity 2 mv for 20-db signal-to-noise ratio. Frequency response from 15 to 15,000 cycles ±1 db, channel separation better than 38 db at 400 cycles. Variable afc and multiplex noise filter. Built-in ferrite loop antenna for AM reception; 300-ohm impedance antenna input for FM reception. 14¾ x 5⅜ x 9½ in.—**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N. Y.

MARINE ELECTRICAL GROUND SYSTEM, kit *No. MD-14,* provides 13.8 sq ft of grounding surface and is designed to be used on both single- and dual-engine craft with minimum keel length of 9 feet. Has 2 heavy-gage copper tubes, 8 ft long and 1¼ in. in diameter, strapped to each side of boat's keel with brass mounting strips and bolts. Only 7 holes needed for permanent mounting, with just one hole through the hull.—**Heathkit Co.,** Benton Harbor, Mich.



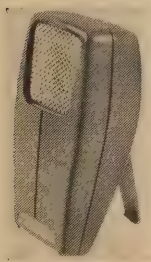
ALL-TRANSISTORIZED 100-WATT AMPLIFIER, *model TA100,* for continuous-duty service. Has: 100 watts rms (200 watts peak) output; thermostatically controlled protective relay; overload protective relay; frequency response ±1½ db, 50 to 15,000 cycles; distortion less than 5% at rated output (less than 3% at 80 watts); noise level 80 db below rated output.—**Rauland-Borg Corp.,** 3535 W. Addison St., Chicago, Ill. 60618

TANTALUM CAPACITORS, *series KSR,* available in 5 case sizes from 180 to 2,400 μf with tantalum hermetic seal. Temperature range of −55°C to +125°C; between 10 and 150 volts with polar construction. Developed for Minuteman program.—**General Electric Co.,** 392 S. Stratford Rd., Winston-Salem, N. C.



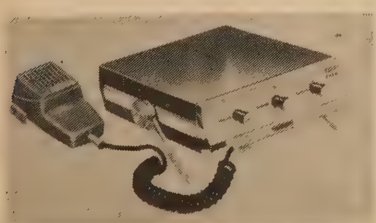
DUAL-POWER-SUPPLY TRANSCEIVER. *Romper* has 8 crystal-controlled transmit and receive frequencies, 7 of them internal and the 8th plugged into a socket in the front panel. Operator can insert crystal cut for any of 23 channels. Operates on 117 volts ac or 12 volts dc. Power consumption on ac is 75 watts normal; on dc 6.5 amps at 12 volts. Uses 10 tubes and 5 diodes—7 dual-purpose tubes provide 17-tube performance. Dual-conversion receiver portion uses 7.5-mc and 455-kc i.f.'s. Relay switching. Frequency range 350 to 3,500 cycles. Squelch adjustable from ¼ μv to about 50 μv. Normal rf and af output is 3 watts; terminals for 3.2-ohm external speaker. 11½ x 5½ x 7⅞ in.—**Regency Electronics, Inc.,** 7900 Pendleton Pike, Indianapolis, Ind.

INDOOR–OUTDOOR SOUND COLUMNS, *CSO-4* and *CSO-6,* with four and six 8-inch speakers, respectively. *CSO-4* handles 80 watts, has frequency response of 70 to 17,000 cycles. Sound projected in horizontal pattern of 120° and vertical pattern of 22°. *CSO-6* handles 120 watts, frequency response of 65 to 14,000 cycles. Horizontal pattern of 120° and vertical pattern of 16°.—**LTV University,** 9500 W. Reno, Oklahoma City, Okla.

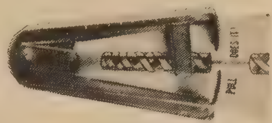


CERAMIC MICROPHONE, *model No. 30-902* for multiple applications. Hand-held or placed on desk. Built-in stand folds flush in back of unit; 6-ft cable terminated with RCA type phono pin plug. For tape recorders, CB transceivers, PA and paging systems.—**GC Electronics Co.,** 400 S. Wyman St., Rockford, Ill.

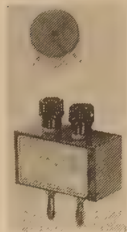
TRANSCEIVER SQUELCH SYSTEM, *Ray-Call* encoder-decoder accessory for most two-way radios. When set is transmitting, *Ray-Call* actuates receiver to which it is attached only when coded tone from similar unit is transmitted. Transistorized, operates from 12 vdc or 117 vac. 1¾ x 5⅞ x 7 in.—**Raytheon Co.,** Lexington, Mass. 02173



ALL-SILICON CB TRANSCEIVER, *model 5000,* for short-range communications (1–20 miles). Plug-in power packs adapt unit for operation on 6, 12, 28 and 32 volts dc or 117 volts ac. Front check-out through test pins in microphone connector allows checkout of modules while set in use. Snap-in modules for replacement of transmitter, receivers, audio, control and power supply modules.—**Pace Communications Corp.,** 520 W. 182 St., Gardena, Calif. 90247



WIRE STRIPPER AND CUTTER, *Strip-It* handles all wire sizes, fits in palm of hand. Fingertip stop adjustment. Insert end of wire, close jaws, twist and pull—wire ready for connection to terminal. Replaceable tool-steel blades.—**Audiophonics Corp,** 95 Rantoul St., Beverly, Mass. 01915



AC INDUCTIVE CURRENT SENSOR, *models A* and *B.* Current transformers for reading ac on ac vtvm or scope. *Model A* measures 100 μa to 10 amps at 400 cycles. Insertion impedance .001 ohm (one low-impedance turn) *Model B* covers 10 μa to 1 amp; impedance .03 ohm. Round and square types. Accuracy ±1% (standard model); ±0.1% with screw adjustment.—**M. B. Gilbert Co., Inc.,** Box 45824, Los Angeles, Calif. 90045 END

All specifications from manufacturers' data.

CARD REMOVED

booklets New Literature charts catalogs

KIT CATALOG, Heathkit 1965 *catalog 810/50.* 108 pages, 16 in full color, illustrating more than 250 electronic kits. Many new products include a new deluxe transistor electronic organ, 21-in. all-channel high-fidelity color TV receiver, and Heath/Mitchell Fotoval computer system, company's latest entry in the photographic equipment field. For the service technician there's a new FM stereo generator kit, plus new kits for hams and CB'ers.—**Heath Company,** Benton Harbor, Mich.

ELECTRONICS CATALOG, *No. 240,* for 1965. 490 pages including parts, hardware, hi-fi components, CB and ham gear, PA and intercom, recorders, test instruments, small-screen portable TV sets, over 100 Knight-Kits, antennas, accessories.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago, Ill. 60680

CCTV CATALOG, 8 pages with photos and specs of a full line of CCTV equipment—cameras, monitors, lenses, housings, video and distribution equipment and accessories—for education, institutional and industrial use.—**Blonder-Tongue Labs,** 9 Alling St., Newark, N.J. 07102

TEST EQUIPMENT CATALOG, 16 pages, looseleaf punched, photos and specs of test equipment for radio and TV servicing, air conditioning, refrigeration and heating.—**Simpson Electric Co.,** 5200 W. Kinzie St., Chicago, Ill. 60644

1965 CATALOG, *No. 650.* 516 pages of electronics components, stereo–hi-fi, Citizens-band equipment, tape recorders, ham gear, test instruments, radios, TV's, cameras, optics, marine equipment, auto accessories, tools, books, etc.—all major manufacturers plus Lafayette's own components.—**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N.Y.

PHONO-DRIVE WALL CHART, 22 x 34 in., lists round and flat rubber belts, rubber tires, fabric drive belts, idler wheels, pressure rollers, turret drives, pulleys, drive wheels, interwheels and miscellaneous phono drive items.—**Walsco Electronics Div. of GC-Textron Electronics,** 400 S. Wyman St., Rockford, Ill.

SUPPLEMENT to electronic components catalog 32, on Fastatch II control system. 8 pages with resistance curves. Controls and accessories necessary for assembly of exact replacements for single, dual, triple and quadruple single-shaft controls, dual concentric controls and units with switches.—**Centralab Distributor Sales Dept.,** Box 591, Milwaukee, Wis. 53201

BROCHURE *MY* with photos, specs and prices on Delta series of hi-fi 12- and 8-inch unitary loudspeakers.—**Jensen Mfg. Co.,** 6601 S. Laramie Ave., Chicago, Ill. 60638.

AUDIO PRODUCTS CATALOG, *SAH-76,* 16 pages, illustrated with specs on ceramic cartridges, equalizers, crystal cartridges and tonearms, replacement needles, microphones, speakers, enclosures, headsets, rechargeable battery cartridges.—**Sonotone Audio Products,** Elmsford, N.Y.

CATALOG of Add-On-Circuits. 24 pages with photos, diagrams of interconnecting amplifiers, converters, single-sideband filters, multivibrator ÷10 dividers, oscillators, power supplies, variable capacitors, potentiometers, transformers, etc.—**International Crystal Mfg. Co., Inc.,** 18 N. Lee, Oklahoma City, Okla. 73102

INTERCHANGEABILITY GUIDE, *No. T-330B.* 24-page guide to interchangeability of foreign and domestic transistors, diodes and rectifiers with Tung-Sol "ET" line. Pocket-size.—**Tung-Sol Electronic Inc.,** 1 Summer Ave., Newark 4, N.J.

PASSIVE ELECTRONIC NETWORKS. 6-page foldout leaflet describes antenna dividing and coupling networks, set couplers, traps for vhf, uhf TV and FM-stereo. Photos, specs and reference chart.—**Channel Master Corp.,** Ellenville, N.Y.

DATA SHEET, *464 PFHH,* specs on Picofuse series of subminiature ceramic fuses (7/32 x 5/64 in. diameter, less than 1/5 gram) for computer, microelectronic and aerospace instrument circuits.—**Littelfuse, Inc.,** Picofuse Lit. Dept., 800 E. Northwest Highway, Des Plaines, Ill.

DATA SHEET on *model 601* ultra-low-range (.001-ohm) ohmmeter and high-capacitance (3,000-μf) meter. Photo and specs.—**Conant Labs,** Box 3997 Bethany Sta. Lincoln, Neb.

NICKEL-CADMIUM BATTERIES CATALOG (*GEA-7678*). 12 pages, illustrated with curves, tables. Applications on standard rechargeable, sealed, button and cylindrical cells.—**General Electric Co.,** Schenectady 5, N.Y.

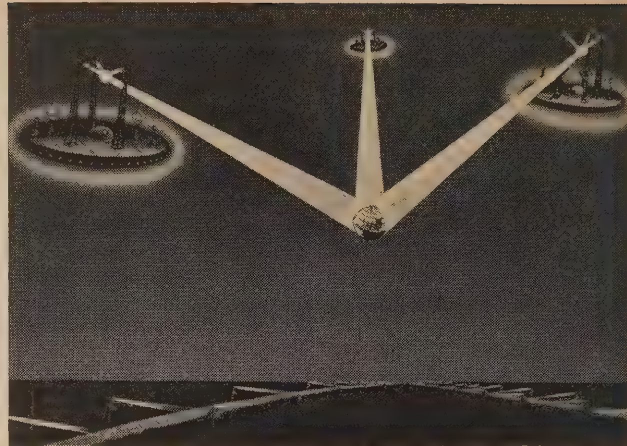
2-WAY RADIO LEAFLET. 4-page description of *Com-Pak model 800* FM pocket 2-way radio (solid-state) with photo and specs.—**Comco, Inc.,** Coral Gables 34, Fla.

CATALOG, *Digest-K.* 16 pages, 2 colors with photos and specs of spectrum analyzers, communications systems analyzers, frequency response plotters, telemetry system test instruments, telephone system measuring sets, accessories, signal generators, and other test instruments.—**Panoramic Instruments, Singer Co., Metrics Div.,** 915 Penbroke St., Bridgeport 8, Conn.

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears.

UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

continued from page 35



Forty-nine years ago the magazine *The Electrical Experimenter* published a science fiction story; Baron Münchhausen's New Scientific Adventures, which ran serially for many months. The November 1915 installment pictured three flying saucers which an interplanetary space flyer held captive by the Martians. The yellow Martian rays also held the humans captive by paralyzing them.

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siles, the space ships, and all the other highly-colored scare stories.

"But truth is stranger than fiction, and Dr. Menzel does far more than debunk. Flying saucers are real, he says, as real as rainbows—and just as hard to catch. Moreover there is nothing new about them: from the famous air-ship of 1897, similar sights (and similar scares) have been known throughout history. These optical ghosts in all their variety of size and shape and color and motion are about for anyone to see: what is new, in our supposedly more rational society, is the air age—more people look at the sky, from below and from above, than ever before." * —*H.G.*

* *Flying Saucers*, published by Harvard University Press, has been out of print for several years. It can be found in most large libraries, or possibly in the following book stores: American Library Service, 353 West 48 St., New York, N. Y.; Barnes & Noble, 105 Fifth Ave., New York, N. Y.; Stechert-Hafner, Inc., 31 East 10 St., New York, N. Y.; Superbooks, PO Box 34, Gedney Station, White Plains, N. Y.; Book Bargains by Mail, 516 Sherman Ave., Pittsburgh, Pa.

COMING NEXT MONTH

ALL-TRANSISTOR ELECTRONIC SWITCH
Make your scope do many of the things for which you would normally need an expensive double-beam oscilliscope. This unit takes two input signals and displays them simultaneously on your scope face. Has two separate amplifiers for the input signals as well as the switching apparatus.

TRANSISTOR SPEED CONTROL FOR HO RAILROADS
Get realistic starting, coasting and braking effects with this easy-to-build unit. Gives your youngster's model railroad stock the "feel" and momentum of a big locomotive. Makes a fine Christmas gift.

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Non-critical in layout and construction, this 10-transistor receiver compares favorably with the better name-brand sets. Construction on copper-clad board gives the advantage of printed circuitry without its problems.

WHAT DO YOU NEED FOR A GOOD SHOP?
Just what equipment is needed to check everything you need to test in TV and radio work? What items would be good to have but aren't absolutely necessary, and what ones can you get along without?

DECEMBER RADIO-ELECTRONICS

ON SALE NOVEMBER 17

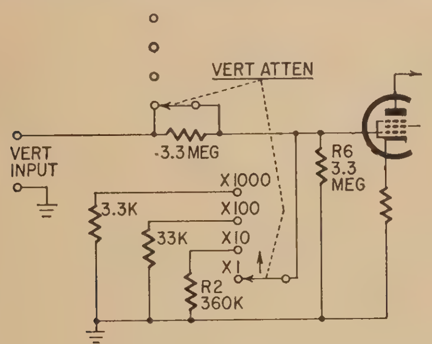
TECHNOTES

HV RECTIFIER TROUBLE

If you have had trouble keeping 1X2's from destroying themselves because of internal arcing, here's a quick cure. The trouble usually shows up on older sets that have had new power and output tubes installed, raising the high voltage to a point where the 1X2 is operating close to its peak voltage. The solution is to place a resistor between the plate cap and the plate lead from the flyback transformer so the peak voltage is reduced. Use the smallest value between 270,000 ohms and 1 megohm that drops the voltage enough. If it is dropped too much, brightness and CRT life will suffer. Use a 1-watt resistor and wrap one lead around the cap. Bend the other lead so it fits snugly into the cap of the transformer lead. If the set is in for a major overhaul, it's a good idea to solder one in on the socket if the factory left it out.—*George Hrischenko*

CORRECTING VERTICAL ATTENUATOR IN EICO 460 SCOPE

Owners of the Eico model 460 oscilloscope may be interested to know that there is an error in the voltage attenuator circuit of this otherwise outstanding service instrument. The error shows up only in the ×10 position of the attenuator and causes voltage amplitude measurements made with this attenuator position to be approximately 10% low. The error is due to the loading effect of R6 on R2, R2 being the resistor



which is switched into the vertical attenuator circuit when the attenuator is placed in the ×10 position. (See diagram)

To correct that, R2 should be changed from 360,000 ohms to 413,000 ohms. There are two ways around that odd value. Several 390,000 ohm, 10% resistors can be measured until one is found with value of 413,000 ohms. If this is impractical, a pair of 820,000 ohm, 5% resistors may be connected in parallel. The resulting combination will have an equivalent resistance of 410,000 ohms, sufficiently close to the desired value.

Corrected this way, the scope will give equally accurate voltage measurements at all settings of the vertical attenuator. —*Peter J. Profera*

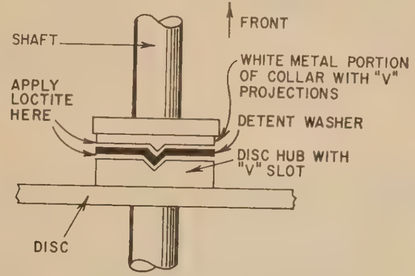
EXTREME CALIBRATION SHIFT IN BROWN INDUSTRIAL RECORDERS

Late-model Brown Electronic recording instruments may be equipped with a constant-voltage unit that replaces the standard cell and No. 6 dry cell. When you service one of these, for the complaint that it gives a reading twice as high as normal, check the output of the Zener constant-voltage unit. If the output is 0.5 volt instead of 1 volt, the trouble is most often a leaky filter capacitor inside the unit. It is a 20-μf 150-volt electrolytic mounted on the printed circuit board. The capacitor (Brown part No. 365356) must be replaced.—*F. G. Lewis*

MECHANICAL FAILURE IN ADMIRAL TV TUNER

The Admiral disc type tuner, first used in portables like the 14YP3, fails because the front disc loosens on the shaft. Angular misalignment between the two discs prevents their contacts from making contact at the same time. Hence, no picture or sound.

Look inside and you will see that the detent washers between the V-slots of the disc and the V-projections of the white



metal portion of the shaft collar assembly are no longer tight. (See drawing.) To repair, rotate the front disc until its contacts engage their stationary fingers properly, then put a few drops of Loctite (Grade A) into the joint and let it harden.

This repair is much simpler than replacing the assembly or trying to put a pin through the shaft.—*H. Q. Duguid*

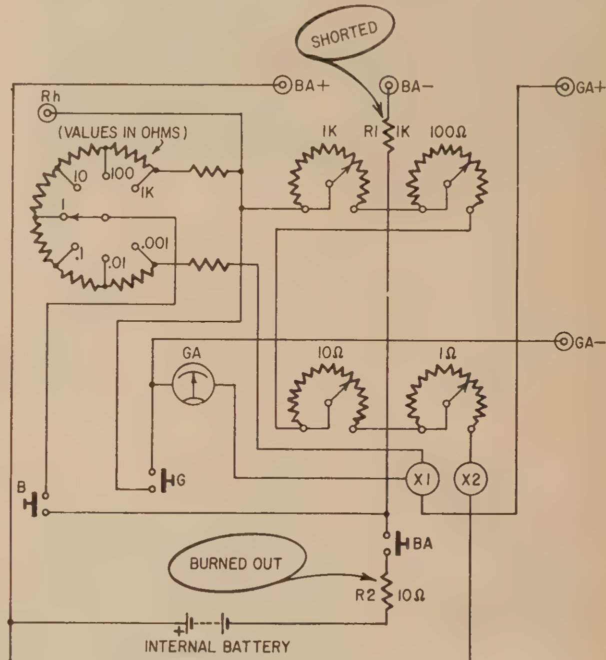
ADMIRAL 19W1: VERTICAL JUMP

An intermittent short in the vertical output transformer caused the picture to jump up and down. Adjusting the height

and linearity controls for a slightly shorter picture made the picture hold still because it cut down on the current through the output tube and transformer. If it had been a defect in the vertical oscillator stage, adjusting the output controls would have had no effect on the jumping.—*Alfred L. Hollinden*

LEEDS & NORTHRUP TYPE S WHEATSTONE BRIDGE

When the battery selector switch was turned to the internal-battery position, with the external supply of 45 volts connected, R2 shunt resistor burned out. After checking the



circuit, I found that R1, a dropping resistor in the external supply circuit, was shorted, placing the full load across R2, which burned out.

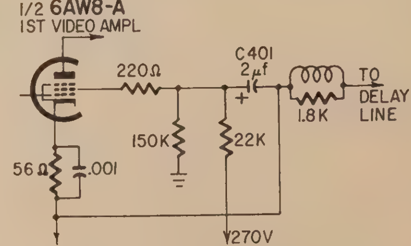
R1 is a ½-watt 1,000-ohm resistor, located at the left of the battery switch. R2 is a 10-ohm shunt, located at the battery switch.—*Clyde Rehberg*

CLEVELAND DIALAMATIC

The ram of a Cleveland Dialamatic (electronically controlled turret lathe) failed to go into low speed in the feed position.

The cam-operated switch controlling the latching relay checked defective. Closer inspection revealed that the basic Microswitch was OK but the roller actuator was hanging up because of dirt under the overtravel plunger.—*R. C. Roetger*

VERTICAL BOUNCE IN RCA CTC9



C401, located on the video board, is often the cause of vertical troubles on this chassis. Just cut one end loose, and, if the vertical bounce disappears or the weak vertical sync is gone, replace it with 2- or 5-μf.—*Arthur Richman* END

Answers to

What's Your Eq?

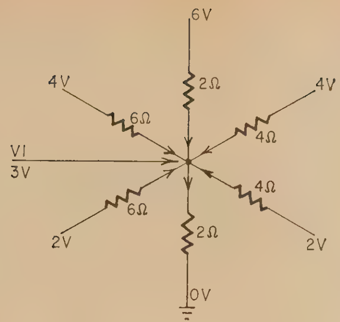
This month's puzzles are on page 57

Ferris Wheel

From Kirchhoff's current law, we see that the algebraic sum of the currents into any junction is equal to zero. As the outer end of all resistors is at a fixed voltage, V1 is the only unknown. Assuming V1 to be 1 volt (any value would do), the current directions are assigned as shown. The equation for the junction currents is now written:

$$\frac{6-V1}{2}+\frac{4-V1}{4}+\frac{2-V1}{4}+\frac{4-V1}{6}+\frac{2-V1}{6}-\frac{V1}{2}=0$$

Using LCD of 12, then eliminating denominators:



$36-6V1+12-3V1+6-3V1+8-2V1+4-2V1-6V1=0$

Collecting terms:

$66-22V1=0 \qquad V1=3$

All branch currents, if needed, now fall easily into place.

Two Meters

The dc ammeter indicates average-current values while the ac ammeter indicates effective or rms-current values. The straight-line graph is used to illustrate their difference. The graph shows a complete cycle of rectangular pulse current in relation to a time base of five 1/300-second intervals. Referring to the figure, the following equation expresses average current, or the dc ammeter reading:

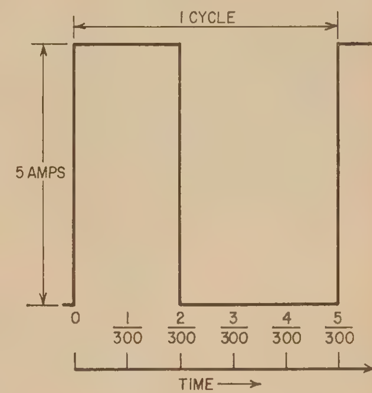
dc ammeter reading $=$

$$\frac{\text{pulse width} \times \text{peak current}}{\text{total cycle time}}$$

Thus: dc ammeter reading $=$

$$\frac{2/300 \times 5}{5/300} = 2 \text{ ampere}$$

The ac ammeter reading is determined by finding the square root of the average value of the squares of the current during the time divisions of one cycle. The current values are: 5, 5, 0, 0,



and 0; the sum of their squares 50, and the average 10 amperes. The ac ammeter reading is the square root of 10, or 3.162 amperes.

END

Dept. JK-4

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technicians' News

RE-ELECT DORST AS NATESA PRESIDENT

Larry Dorst, Milwaukee, has been re-elected president of the National Alliance of Television & Electronics Service Associations at the group's annual meeting in the Edgewater Beach Hotel.

Tom Hudson, Lynchburg, Va., was named secretary-general. He succeeds Earl Steffes, Kansas City, Mo.

Treasurer is Len Gregson, Davenport, Iowa, who succeeds H. O. Eales, Oklahoma City.

Other officers include: Carl Johnston, Washington, D. C., succeeding Richard E. Ambrose, Norfolk, Va., as Eastern vice president; John Gibson, Roanoke, Va., succeeding Mr. Hudson as Eastern secretary.

King Camden, Kansas City, Mo., succeeds T. L. Childs, Fort Smith, Ark., as West Central vice president, and Nolan Boone, Little Rock, Ark., succeeds Clarence Thole, St. Paul, Minn., as West Central secretary.

Clyde Ellis, Seattle, Wash., succeeds Alan Pickel, Los Cruces, N. M., as Western vice president. Raymond Tuszinski, Butte, Mont., was re-elected Western secretary.

Lyle Green, Oak Park, Ill., and Andy Archie, Nashville, Tenn., were re-elected East Central vice president and secretary, respectively.

HAROLD WILLIAM LAKEMAN

Harold William Lakeman is sought by the Federal Bureau of Investigation as a fugitive on a charge of rape. He allegedly raped a 13-year old girl on the evening of July 9, 1958 in Lexington, Mass.

Lakeman, pictured here, fled the Boston area. His car was located abandoned on July 23, 1958, at Rocky Hill, Conn. The fugitive has worked as a stock clerk and cleaner for a bus company and as a messman in the U. S. Merchant Marine from 1942 to 1945. Prior to Lakeman's flight from Massachusetts, his occupation was television repairman and he was formerly a partner in a television repair business.

Lakeman is a white American, born Oct. 24, 1923 at Lynn, Mass. He is 5 feet 8 inches tall, weighs 176 pounds, has blue eyes and brown hair. He has a small scar on the bridge of his nose.

Any person who can furnish information concerning Harold William Lakeman's whereabouts is urged to notify immediately the nearest office of the Federal Bureau of Investigation. Consult the first inside page of your phone book for the number.

No action should be taken which would in any way endanger a member of the public.

CATV: THREAT TO INDEPENDENT TECHNICIAN?

Frank Moch, executive director of the National Alliance of TV & Electronics Service Associations, called community antenna television (CATV) a threat to the independent technician in

his keynote address before the annual meeting of the association.

CATV, he said, was originally operated by local groups, and was intended to supply TV to communities isolated by mountains or having other special problems. But, he said, "suddenly the movie industry is pouring money into it at the rate of $25 million at a time. Major antenna companies are investing large amounts of money and only a few days ago a major network was reported as buying 18 small cable TV companies in the East. And talk of systems for big cities is running wild."

Mr. Moch believes that the real danger in these systems is that they "will cloak themselves with a quasi-utility status and, when that happens, the cable company will supply the program, the means of bringing the program, the set and the maintenance so as to assure the public the most use, and thus the most revenue for themselves."

Moch also told the group that the NATESA apprentice program may help fight the current war on poverty, and has already made "great strides." NATESA, as the only accepted agency administering the apprentice program, will soon have the help of a full-time paid agent of the Labor Department in launching the program on a nationwide basis.

The NATESA annual convention was held in Chicago August 14–16.

SERVICE, EXCISE, AIRED BY TEXANS

Service problems, the uhf market and relief from Federal excise taxes on all-channel receivers were among the topics taken up at the Texas Electronics Association's annual convention at Galveston. The emphasis at all the meetings was increased profits through effective management decisions.

RCA distributed transcripts of testimony in behalf of excise tax relief before the House Ways and Means Committee at the convention. The testimony had been delivered by RCA's Delbert L. Mills.

The Houston Better Business Bureau distributed a circular pointing out ways to eliminate misleading advertising.

D. W. Donald, a Fort Smith, Ark., technician, said in his talk before the group that the service industry has the second highest mortality rate in the nation. "We often fail to seek out business, and when we get it, we often make inept sales with far-reaching effects," he said. He urged more advertising, improved shop appearance, more effective personal contact, quicker response to service calls and detailed checkups when on a service call.

W. D. Renner of the Howard W. Sams Co., Indianapolis, echoing the sentiments of Mr. Donald, said that too often servicing is considered something to be written off as a loss or to be juggled in the hope of breaking even. Noting that electronics repair involves far more than just television and radio, he urged members to go after business fixing other kinds of electronic equipment. "Somebody has to repair them," he noted, "and if you don't, someone else will."

Scott Hansen, manager, dealer development, distributor sales operations, General Electric Co., discussed methods for stepping up sales. Among his suggestions were: concentrating price groups in display, stepup pricing through offering a better bargain than the advertising leaders, and add-on sales.

OTHER NATESA CONVENTION NEWS: INDIVIDUAL MEMBERS; CATV BLAST

The National Alliance of TV & Electronic Service Associations is going after individual service dealers for membership in areas where it does not have an affiliate. The decision came in the last moments before adjournment of the group's annual convention.

Frank Moch, NATESA executive director, explained that this is the first time NATESA is ignoring any organization in an area where there is no affiliate.

The individual will become a member of the national body and, when there are enough members in an area, a group will be formed.

In other business, a resolution construed as an indirect slap at community-antenna television (CATV) and pay television, was approved at the final session of the NATESA annual convention.

The resolution reads: "Be it resolved that this Alliance goes on record as being opposed to any form of TV programming, regardless of the method used, which in any way limits the rights of professional independent service business to compete."

RCA SALES WINS NATESA AWARD

The National Alliance of TV & Electronics Service Associations "Friends of Service" award has been given to RCA Sales Corp. This is the first such award to the TV set division.

Continuing awards were voted to the RCA Tube Division; Finney Co., antenna manufacturer; Tung-Sol Tubes; Raytheon Tubes; Sylvania Tubes; Philco Accessory Division; General Electric Tubes and the Howard W. Sams & Co. Zenith Radio was given a continuing award as Friend of Service in the set division.

DIRECT MAIL TECHNIQUES BRING IN CUSTOMERS

Mail is an effective medium for getting service business, said former NATESA president Vincent Lutz, speaking before the Alliance's annual national convention.

Lutz told members that his experience with direct mail has shown that it pays off better than any other medium he has used.

To be effective, Lutz said, the campaign must be continuing, and should be "individualized" by the use of such things as commemorative stamps.

A few days after a service call, his company sends the customer a "thank-you letter."

He also recommended Christmas cards as a valuable tactic, provided that they are sent so the customers receive them by about Dec. 1. That way "the customer will remember the card because it probably will be one of the first he receives."

This delicious little morsel appeared in *ERSDA*, the official publication of the Electronic Retail Service Dealer's Association, Calgary, Alberta.

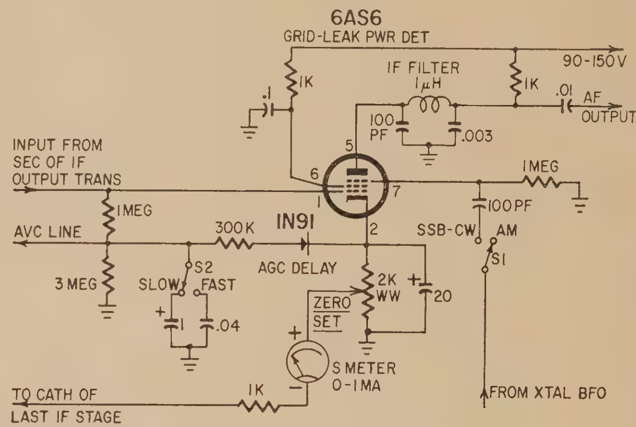
"We note with some glee that one of our larger tube-selling drug emporia has been rapped on the knuckles for selling electronic accessories in contravention of the Lord's Day Act.

"With God's help we may beat these fellows." END

noteworthy Circuits

NEW DETECTOR FOR SSB, CW AND AM

The average communications receiver is designed for AM and CW signals and is not very satisfactory for serious SSB work. It uses a single diode or a pair of diodes as the AM detector and avc source. Although avc is desirable for all modes of reception, ordinarily it must be disconnected for CW and SSB reception. Otherwise, the bfo develops enough avc voltage to reduce the set's sensitivity seriously. Product detectors and other special circuits have been developed for sets designed for good SSB reception.



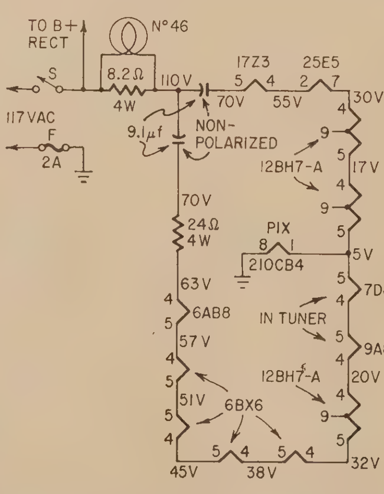
The circuit shown, taken from Philco's *TechRep Bulletin,* was developed for optimum performance on AM, CW and SSB signals and was used to replace the detector and avc circuits in a AM, CW and SSB receiver. A patent is pending.

When S1 is in the AM position, the bfo is disconnected. The incoming i.f. signal is rectified in the grid–cathode circuit, and the detected signal is amplified in the plate circuit. Avc (or agc) is taken off the cathode circuit. The 1N91 diode delays avc action until the signal strength reaches a satisfactory level. S2 selects the speed with which the avc follows signal-strength variations.

On SSB and CW signals, the bfo signal is fed to the suppressor and mixes with the incoming signal in the plate circuit. The bfo input is isolated from the detector circuit so it does not affect the avc level.

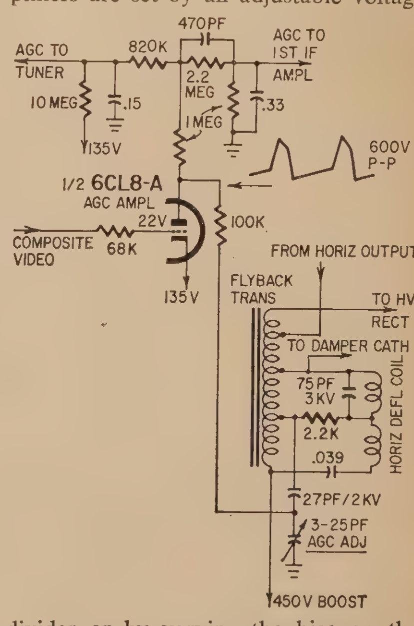
UNUSUAL SERIES STRING CIRCUIT

In most TV sets with series-string heaters, the sum of the heater voltages equals the line voltage, or the excess voltage is dropped across a series resistor. Recently I noticed an unusual circuit where nonpolarized electrolytics are used in place of dropping resistors in series heater strings. This arrangement is in the Delmonico 8PV-47U. The basic heater strings are shown in the diagram. Rf filter chokes and capacitors have been omitted for simplicity.—*Ray D. Brookins*



NOVEL AGC CONTROL

Most keyed agc circuits are gated by a constant-amplitude pulse from the horizontal output circuit. The levels of the agc voltage on the tuner and i.f. amplifiers are set by an adjustable voltage divider or by varying the bias on the keyer tube. Westinghouse uses this unusual circuit in the V-2443-1 chassis. The agc tube operates with a fixed bias level and the flyback pulse is tapped off



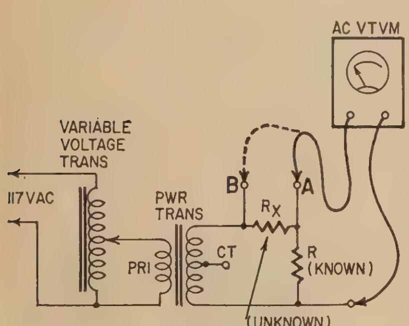
a variable capacitive voltage divider consisting of a 27-pf capacitor and a 25-pf trimmer. Adjusting the trimmer sets the amplitude of the keying pulse. This, in turn, determines the agc voltage developed by the incoming signal.

The trimmer is located on the chassis near the left edge of the high-voltage cage. To adjust the circuit for optimum performance, connect a scope to the video-amplifier grid test point and tune in the strongest station. Adjust the trimmer for a 2.75-volt peak reading. If a scope is not available, tune in the strongest station. Adjust the trimmer until the picture starts to bend at the top and then back off the control until the bend just disappears.—*Henry O. Maxwell*

MEASURING ULTRA-HIGH RESISTANCES

Resistors up to 10,000 megohms and often higher are used in the input circuits of electrometers, in pH bridges, high-voltage probes and some vtvm's. Expensive when new, they are sometimes available on the surplus market for a small fraction of their original cost. Most are in glass envelopes (see photo), and the markings may have grown indistinct or illegible with age and mishandling.

How do we measure these resistors? Here is a simple method that is quite accurate, uses simple equipment



and does not require the dangerous high voltages that are used in ohmmeter measurements. The diagram shows the setup. All we need is a variable-voltage ac source such as a Variac, a small power transformer, an ac vtvm with millivolt and volt ranges, and R, a precision resistor of around 10,000 ohms. The Variac (you can substitute a heavy-duty pot of around 1,000 ohms, 25 watts) sets the voltage applied to the primary of the power transformer.

Set the voltmeter on its lowest range with the probe connected to point A. Adjust the Variac (or the pot) for a reasonable reading, say 2 mv. Now, measure the voltage at B on a high-voltage range. Let's say that this reads 200 volts. The unknown, R_x, can be computed from the formula

$$\frac{V_B}{V_A} = \frac{R_x + R}{R}$$

If R is 10,000 ohms, it is insignificant compared to R_x so we can ignore it in the numerator on the right side of the equation. Rearranging, we have

$$R_x = \frac{V_B \times R}{V_A}. \text{ Substituting,}$$

$$R_x = \frac{200 \times 10{,}000}{.002},$$

or 1,000,000,000 ohms.

One thousand megohms!

Dropping R from the numerator, affected the answer only about .001%. Considering all other possible errors, the calculated value of R_x will be at least within 3% and, at best, a small fraction of 1%.

For higher values of R_x, use 50,000- or 100,000-ohm resistors for R.—*Tom Jaski*

END

LACQUER THINNER SECURES PLASTIC KNOBS

When you want a plastic knob to stay permanently secure and never loosen or be removed from a component or tool, put a few drops of lacquer thinner inside the knob, wait a few seconds and re-install the knob. Let it set 5 minutes before using. It'll never get loose again.—*Stan Clark*

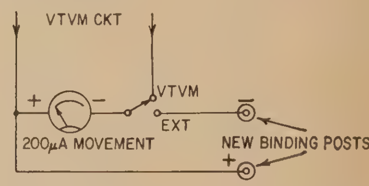
MAGNET "FEELS" TRANSFORMER FIELDS

When you want to gage the strength of a stray magnetic field around a power transformer or motor, grip a small permanent magnet between thumb and forefinger and bring it near the transformer while the transformer is under load.

You'll feel the 60-cycle vibrations in your fingers, and moving the magnet around will give you a fair qualitative idea of the size and shape of the field.—*Tom Jaski*

METER BORROWING SAVES EXPENSE

I often need a 200-μa meter movement for experimental circuits. The one in my vtvm is just that, but using it always meant getting inside the case to



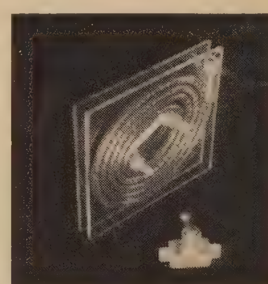
disconnect it from the vtvm circuit.

I changed that by mounting an spdt slide switch and a pair of binding posts on the side of the case, wired as shown in the diagram.

When you've installed the binding posts, mark the meter polarity on the case next to them. Be sure that whatever circuit you use the meter in won't force enough current through to damage it.—*Albert Koehler*

HIGH-VOLTAGE CAPACITORS OUT OF COAX CABLE

When the need arose for some high-voltage capacitors of values not available from electronic supply houses, I concocted some very satisfactory substitutes by making flat coils 3 or 4 inches in diameter, consisting of several turns of RG-59/U coaxial cable. The



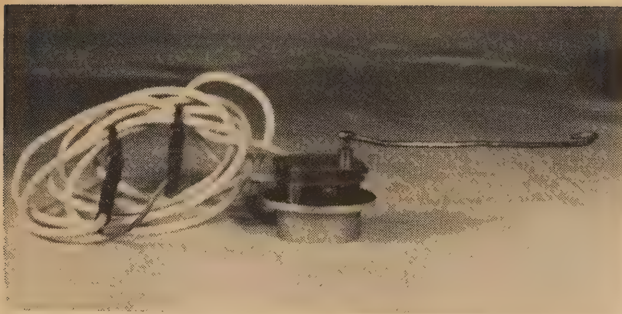
solid conductor served as one "plate" while the shield, stripped back a few inches to prevent flashovers, served as the second.

It worked so well that several different lengths were coiled and mounted permanently between clear acrylic plastic plates with terminals. The cable insulation will easily withstand repetitive pulses of 15 kv for several months without failure.

RG-59/U has a capacitance of 21 pf per foot.—*John W. Deely*

TUBELESS, TRANSISTORLESS AUDIO SWEEPER

You can make a really simple audio sweep generator by brazing a 4-inch torque arm to the shaft of a geared syn-



chronous motor—the type used for display rotators or timing devices. The photo shows a Bristol Motors model 444-C, a 60-cycle 4-rpm device salvaged from a rotating wristwatch display. When the shaft is spun at 16 rpm by the "crank", a 250-cycle 300-mv signal comes out. The output impedance is 3,000 ohms. Attach an output cable and put alligator clips on its other end.

This unit is great for chasing low-frequency rattles out of speaker enclosures, especially guitar speaker boxes. Spin the shaft; as it slows down, the audio range is swept smoothly. A resonant rattle can't easily escape detection. The "generator" takes 10 seconds to slow down from 32 rpm, and make a smooth sweep from 500 cycles down. The output is pure sine wave. The rotator arm is 4 inches in length and is brazed onto the rotator shaft.

The unit in the photo is made by Bristol Motors, Old Saybrook, Conn.—*Steve P. Dow*

continued on page 109

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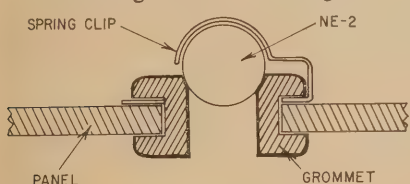
continued from page 107

CLIP AND GROMMET MOUNT NEON LAMP

The NE-2 neon bulb is often an attractive choice as a pilot lamp because of its low cost, small size, rugged construction and remarkably low power consumption. At the same time, it can do other jobs in many circuits, such as a waveform generator or voltage refer-



ence. But many experimenters don't take advantage of it because of mechanical difficulties in mounting this baseless bulb.

I've found it convenient to mount NE-2's in spring clips like that shown in the diagram. The clip can be cut from any available thin sheet metal—even an old tin can. The clip is fastened to the panel with a grommet such as those used by dressmakers and sold in a variety of colors at the notions counters of most department stores. The grommet, which is selected in a color to harmonize with the panel, not only holds the assembly in place, but also provides an attractive "lens" for the light.—*John P. Wentworth*

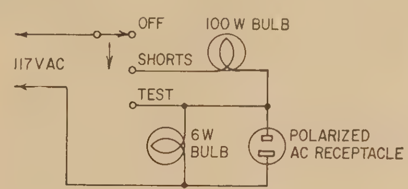
SHORT-TEST BOX

I recently revived this ancient gadget for use with TV and small electrical appliances, which sometimes blow fuses.

I start with the switch in the SHORTS position. If the 100-watt bulb lights brightly, there's a short in the set. If not, I switch to TEST.

Sometimes, after voltage checks show the need for resistance checks, I forget to shut off the TV. The red jewel on the 6-watt pilot light warns me—usually!

In the SHORTS position the 6-watt



pilot light dims if I plug in an appliance, which shows absent-minded me that I'm still on SHORTS.—*Nate Silverman*

TUBE-CADDY SPEAKER SPEEDS AUDIO CHECKS

Each of our service technicians has a small test speaker installed in his tube caddy. Its leads are long enough to reach the chassis for checking audio output on service calls.—*Stan Clark* END

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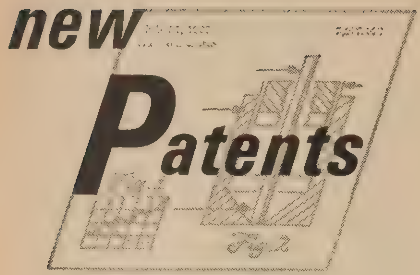


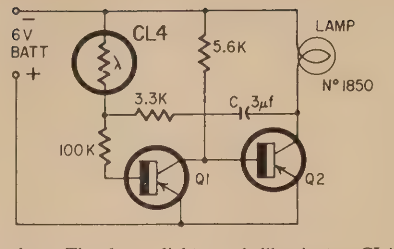
Transistor Flasher

Patent No. 3,130,349

Henry R. Mallory, Greenwich, Conn. (Assigned to P. R. Mallory & Co., Inc., Indianapolis, Ind.)

Q1 and Q2 are connected so that only one of them is conducting at any time. For example, if Q1 conducts, it drives Q2's base more positive and blocks it. The CL4 photocell is placed where it is affected both by lamp illumination and by ambient light. The lamp lights only when Q2 conducts.

In daylight the resistance of CL4 is low. Therefore considerable current can flow from the negative battery terminal to the base of Q1, which conducts. The lamp remains dark. In darkness, CL4 has high resistance, and very little base current can flow to Q1. It blocks. Q2's base, which is negative at this time, permits the transistor to



conduct. The lamp lights and illuminates CL4, lowering its resistance, as in daylight. This extinguishes the lamp.

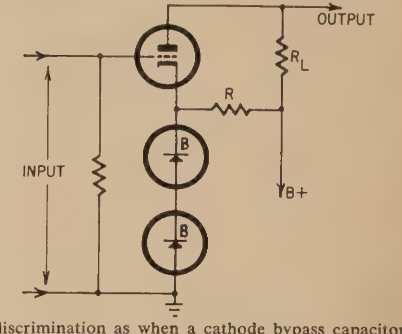
The lamp will flash on and off at a rate determined by the charge and discharge of C. With values shown, the frequency is once per second. The duty cycle is 10% on, 90% off.

Zener Cathode Bias

Patent No. 3,129,388

Richard E. Lang, Concord, and Charles H. Smith, Attleboro, Mass. (Assigned to USA as represented by Secretary of Navy)

Zener diodes improve efficiency and increase power output of an amplifier, whether class A, B or C. As shown in the schematic, they are useu in the cathode circuit to stabilize bias. There is no need for a separate bias battery, and no degeneration dut to a resistor. There is no frequency



discrimination as when a cathode bypass capacitor (even a large one) is used.

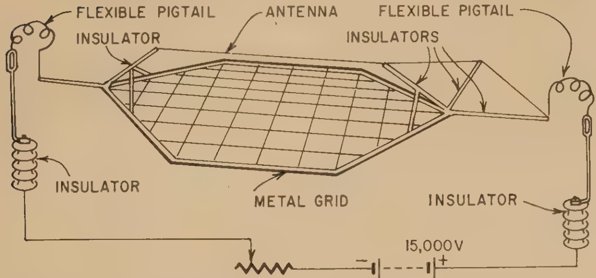
The Zeners (one or more may be needed) can be energized from the plate supply as shown. Resistor R may not be needed in circuits where total cathode current is great enough.

RADIO-ELECTRONICS

Flying Device

PATENT No. 3,120,363

Glenn E. Hagen, Fresh Meadows, N.Y. (Assigned to Electronatom Corp., New York, N.Y.)



This device consists of an insulating frame which carries a grid of fine wires. The wires are connected to a source of high-voltage negative dc. Above this grid, and insulated from it, is a single-wire antenna connected to the positive terminal.

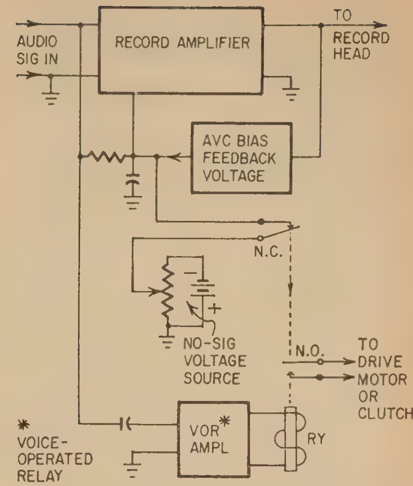
Positive ions are emitted downward from the antenna and attracted by the grid to provide lifting power. In one experiment, the frame was approximately 4 x 6 in. and the antenna was 2 in. above the grid. All wires were 2.5 mils in diameter.

Controlled-Volume Recorder

Patent No. 3,132,213

Douglas E. Taylor, Westport, and William F. Mitchell, Fairfield, Conn. (Assinged to Dictaphone Corp., Bridgeport, Conn.)

A dictating machine can be started and stopped by the voice signal, as shown here. The audio actuates a voice-operated relay (VOR) whose contacts close the motor circuit. Other contacts open at this time, to permit normal avc action on the amplifier



During a pause (when the relay is not energized) a negative battery voltage is added to the avc supply. It reduces amplifier gain and prevents the loud "plop" that would otherwise occur when the audio resumed. The plop happens because amplifier gain is maximum when there is no avc to hold it down. END

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A listing of over 10,000 American and foreign tubes. Special types, pix tubes and subminiatures are included.

UNDERSTANDING TRANSISTORS, by Milton S. Kiver. *Allied Radio, 100 N. Western Ave., Chicago 80, Ill. 6 x 9 in. 64 pp. Paper, 50 cents.*

Interesting little booklet, covering fundamentals and containing large numbers of simple transistor circuits.

103 SIMPLE TRANSISTOR PROJECTS, by Tom Kneitel. *John F. Rider Publisher, Inc., 116 W. 14 St., New York, N.Y. 10011. 5½ x 8½ in. 120 pp. Paper, $2.75.*

Contains everything from simple receivers through frequency standards to Geiger counters. Schematics exceptionally large and clear.

CALCULUS FOR THE ELECTRONICS TECHNICIAN, by Allan Lytel. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 5½ x 8½ in. 160 pp. Paper, $3.95*

Tells his reader what calculus is, then presents the subject in a little more detail than the average textbook. No attempt is made to relate the various examples to electronics problems.

ENGINEERING MATHEMATICS, by Kenneth S. Miller. *Dover Publications, Inc., 180 Varick St., New York 14, N.Y. 6 x 8½ in., 417 pp. Paper, $2.*

Linear differential equations, Fourier series, Laplace transforms and probability theory are among the advanced topics presented here for graduate engineers. Excellent for original study or for review.

SCHWARZ-CHRISTOFFEL TRANSFORMATION AND ITS APPLICATIONS, by Miles Walker. *Dover Publications, Inc., 180 Varick St., New York 14, N.Y. 5½ x 8½ in., 116 pp. Paper, $1.25.*

Elementary explanation of this important method for solving engineering problems of force fields and fluid flow. The reader must know calculus and complex algebra.

ABC's OF LASERS AND MASERS, by Allan Lytel. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind., 4300 W. 62 St., Indianapolis 6. Ind. 5½ x 8½ in., 95 pp. Paper, $1.95.*

An introduction to these amazing devices, and how they are used.

ENCYCLOPEDIA OF HIGH FIDELITY, 6 vols., each by a different author (John Borwick, Ed.). *Focal Press, Inc., 20 E. 46 St., New York, N.Y. 10017. 5¾ x 8¾ in., approx. 1,500 pp. total all 6 vols. Cloth, in slip case, $9.50 each vol., $49 for whole set.*

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the beginner in electronics, to the highly sophisticated, for the experienced designer who wants new ideas or a comprehensive reference work. Mathematical approaches are used for those who can benefit by them, but no knowledge of math is necessary to understand the material. British, but it shows up only in tube and transistor types and a few matters of style. A goldmine for the audio engineer or technically oriented audiophile.

ON THE EARLY HISTORY OF RADIO GUIDANCE, by Benjamin Franklin Miessner. *San Francisco Press, 255 12 St., San Francisco, Calif. 5¾ x 8½ in., 86 pp. Paper, $2.75*

The author's own account of his role in developing radio guidance while in the employ of John Hays Hammond. Throws some additional light on the controversy between Hammond and Purington and Lloyd Espenschied (*Proceedings of the IRE*, 1957–1959).

REPLACEMENT GUIDE FOR TV AND AUTO RADIO CONTROLS (Volume 6), compiled by Howard W. Sams Engineering Staff. *Howard W. Sams & Co., 4300 W. 62 St., Indianapolis 6, Inc. 8½ x 11 in., 192 pp. Paper, $1.*

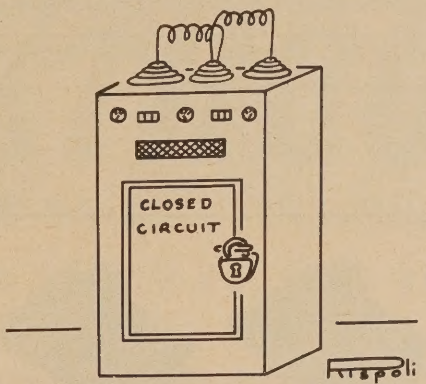
Lists recommended replacement controls produced by Centralab, Clarostat, CTS-IRC and Mallory for more than 38,000 TV models and 1,500 auto radios produced from 1947 through 1964.

A PROGRAMMED COURSE IN BASIC TRANSISTORS, by New York Institute of Technology, Alexander Schure, project director. *McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 10036. 7 x 10 in., 473 pp. Paper, $7.95*

A very large and complete work, using the reinforced-response approach. May depend to some extent on outside reading, since some of the answers require using words not previously introduced in the text.

RCA RECEIVING TUBE MANUAL, RC-23. *Electronic Components & Devices, RCA, Harrison, N.J. 5¼ x 8¼ in., 608 pp. Paper, $1.25*

The latest edition, *RC-23*, has been expanded to 608 pages from the 544 pages of the RC-22. The technical data section, containing more than 400 pages, covers active RCA receiving types. Renewal and discontinued types are combined in a 50-page tabular section, containing data on over 500 tubes. END



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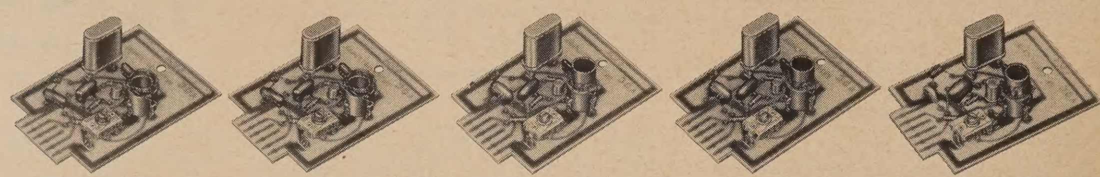

HIGH FREQUENCY (20 mc — 160 mc)

Five transistor oscillators covering 20 mc - 160 mc. Standard 77°F calibration tolerance ±.0025%. The frequency tolerance is ±.0035%. Oscillator output is .2 volts (min) across 51 ohms. Power requirement: 9 vdc @ 10 ma. max.

OSCILLATOR TYPE	OSCILLATOR RANGE	CRYSTAL TYPE	TEMPERATURE TOL. —40°F to 150°F	OSCILLATOR (LESS CRYSTAL) PRICE
OT-24	20-40 mc	CY-7T	±.0035%	$ 9.10
OT-46	40-60 mc	CY-7T	±.0035%	9.10
OT-61	60-100 mc	CY-7T	±.0035%	15.00
OT-140	100-140 mc	CY-7T	±.0035%	15.00
OT-160	110-160 mc	CY-7T	±.0035%	15.00

CRYSTAL FREQUENCY	CRYSTAL PRICE
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141-160 mc	18.00

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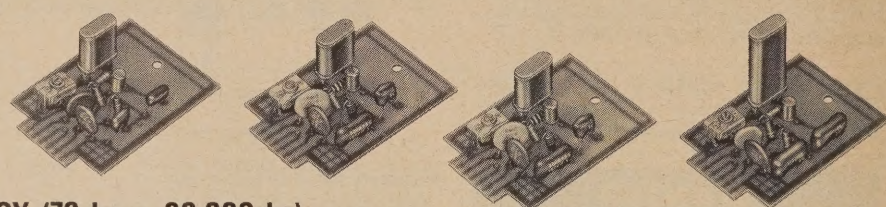
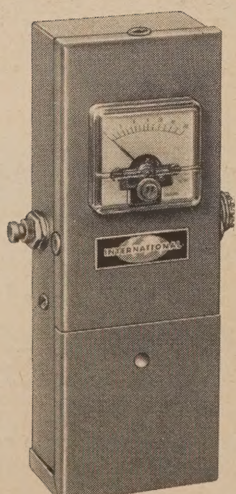


LOW FREQUENCY (70 kc — 20,000 kc)

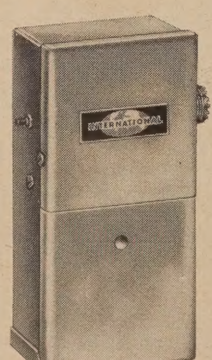
Four transistor oscillators covering 70 kc - 20,000 kc. Trimmer capacitor for zeroing crystal. When oscillator is ordered with crystal the standard will be ± .0025%. Oscillator output is 1 volt (min) across 470 ohms. Power requirement: 9 vdc @ 10 ma. max.

OSCILLATOR TYPE	OSCILLATOR RANGE	CRYSTAL TYPE	TEMPERATURE TOL. —40°F TO + 150°F	OSCILLATOR (LESS CRYSTAL) PRICE
OT-1	70-200 kc	CY-13T	±.015%	$7.00
OT-2	200-5,000 kc	CY-6T	200-600kc ±.01% 600-5,000kc ±.0035%	7.00 7.00
OT-3	2,000-12,000 kc	CY-6T	±.0035%	7.00
OT-4	10,000-20,000 kc	CY-6T	±.0035%	7.00

CRYSTAL FREQUENCY	CRYSTAL PRICE
70-99 kc	$22.50
100-200 kc	15.00
200-499 kc	12.50
500-849 kc	22.50
850-999 kc	15.00
1,000-1,499 kc	9.80
1,500-2,999 kc	6.90
3,000-10,999 kc	4.90
11,000-20,000 kc	6.90



FOT-20



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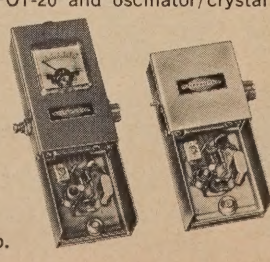

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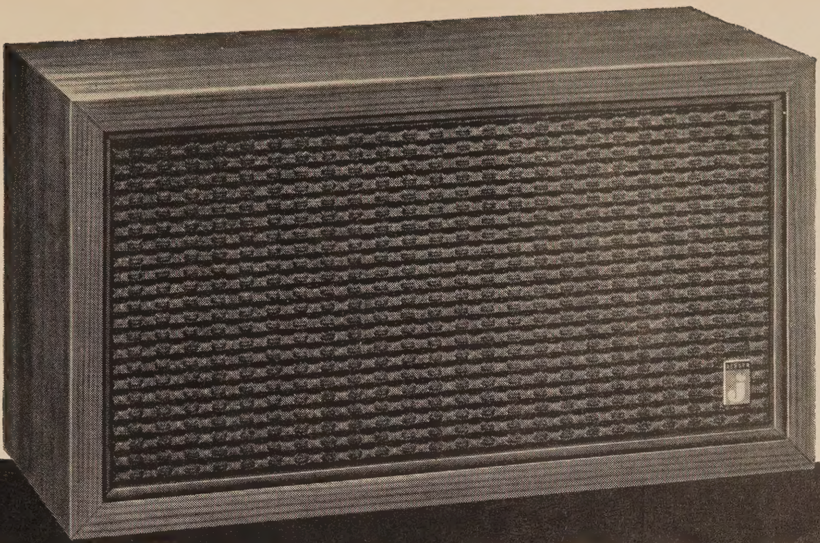

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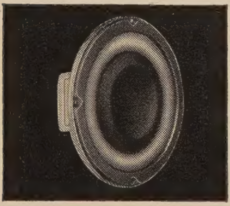

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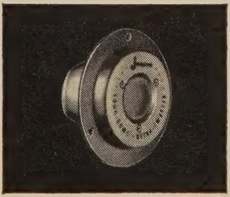

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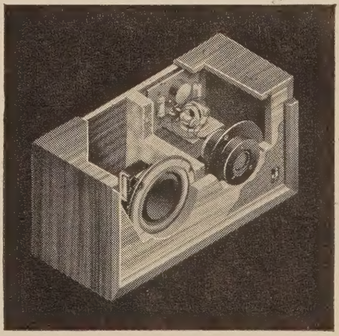

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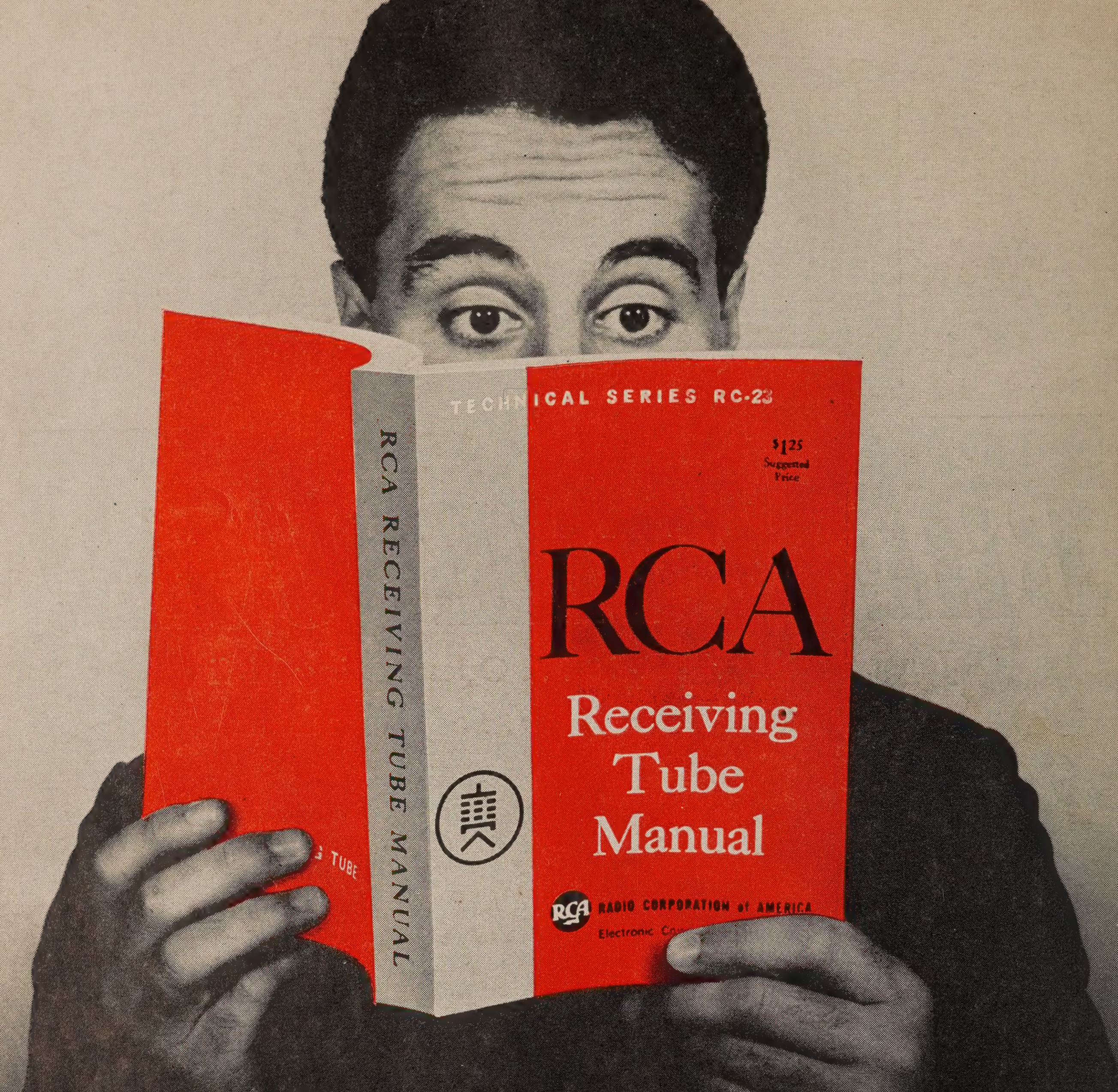

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